CLARK FORK BASIN PERIPHYTON MONITORING:

AN ASSESSMENT OF BIOLOGICAL INTEGRITY AND IMPAIRMENT BASED ON ALGAE ASSOCIATIONS DURING AUGUST OF 1997 AND 1998

prepared by:

Erich E. Weber

***Phyco*Logic**
East Helena, Montana

prepared for:

State of Montana
Department of Environmental Quality
Planning, Prevention and Assistance Division

June 1999

CONTENTS

LIST OF TABLES

LIST OF FIGURES

SUMMARY

Periphyton (benthic algae) samples were collected by a contractor for the Montana Department of Environmental Quality (DEQ), Planning, Prevention and Assistance (PPA) Division from natural substrates at 25 locations on the Clark Fork of the Columbia River and major tributaries during mid-August of 1997 and 1998. This monitoring was conducted for the purpose of assessing water quality, biological integrity and overall impairment of aquatic life as part of the ongoing Clark Fork Basin Project. Similar algae surveys have been conducted annually by the State of Montana since 1986.

Samples were analyzed for relative abundance of non-diatom algal genera, dominant non-diatom phylum, and relative abundance of diatom species. The total percent relative abundance of diatom species in each of three pollution tolerance groups were calculated. Diatom metrics calculated included: diatom species richness, Shannon species diversity, pollution index, siltation index and percent similarity index. An assessment protocol (Protocol I) utilizing specific criteria based on diatom metrics was used to determine biological integrity and overall impairment of aquatic life at each station monitored during 1997 and 1998. Protocol I relied on values determined from least-impaired reference streams in western Montana for comparison purposes.

Streamflows throughout the Clark Fork Basin were much higher during the August 1997 monitoring period than during 1998. The high instream flows contributed to the greater degree of impairment indicated at many stations during 1997.

Blacktail Creek, the principal headwater tributary to Silver Bow Creek, had fair biological integrity with moderate impairment of aquatic life during 1997, and good biological integrity with only minor impairment of aquatic life during 1998. Diverse non-diatom and diatom algae assemblages indicated relatively unimpaired water quality during both years.

The three upper Silver Bow Creek sites: a) above the Butte wastewater treatment plant (WWTP); b) downstream of the WWTP and the Colorado Tailings; and c) above the Warm Springs Ponds at Opportunity all exhibited moderate to severe overall impairment of aquatic life and fair to poor biological integrity in during 1997 and 1998. Elevated levels of sediment, heavy metals, biogenic wastes and nutrients continued to seriously impact this reach, although some improvement was evident above the Butte WWTP during 1998 as a result of Superfund remediation efforts. Moderate biological impairment was seen at Silver Bow Creek downstream of the Warm Springs Ponds in 1997, but only minor impairment indicated improved water quality in 1998.

Warm Springs Creek had fair biological integrity with moderate impairment of aquatic life indicated during both 1997 and 1998 due to possible sediment impacts, but water quality remained relatively high in this important tributary to the upper Clark Fork.

Biological integrity was fair to poor in the Clark Fork between Warm Springs Creek and the Little Blackfoot River during 1997, with moderate to severe impairment indicated. Sediment was apparently the primary cause of the impairment, although sources of nutrients and metals are present

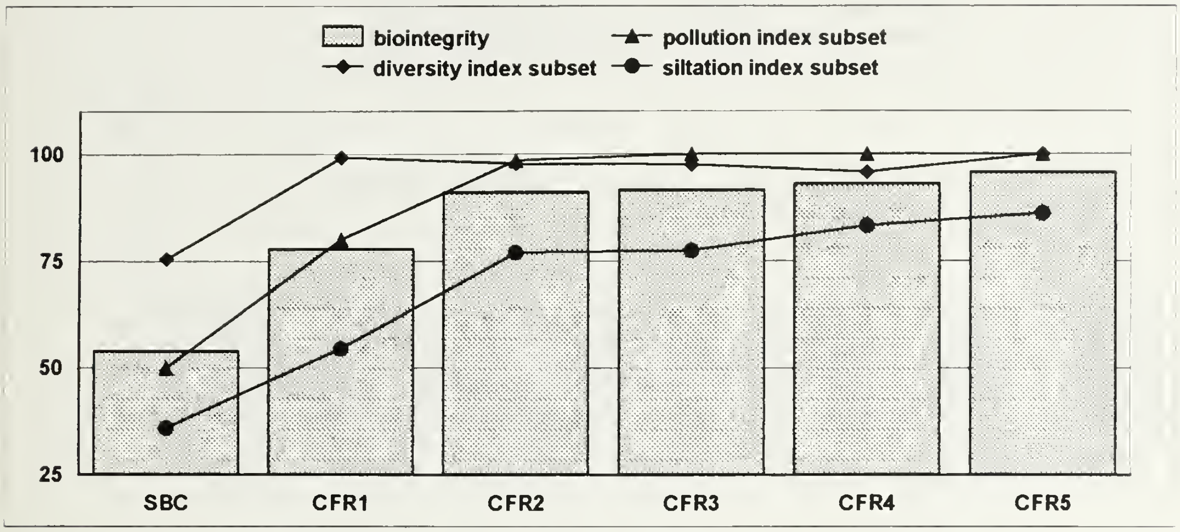
in this reach. Conditions improved slightly in this reach in 1998, but generally moderate impairment ratings indicated continued problems in the Clark Fork upstream of the Little Blackfoot River.

Biological integrity in the Clark Fork between the Little Blackfoot River and Missoula during 1997, was only fair at the upstream stations, but generally improved at the lower stations. In 1998 biological integrity was generally good throughout the reach, and aquatic life only slightly impaired due to sediment. Major tributaries to the upper portion of this reach, the Little Blackfoot River and Flint Creek, were slightly to moderately impaired due to sediment during both years. Rock Creek and the Blackfoot River, large tributaries to the lower end of this reach, were essentially unimpaired during both years. High-quality waters from these tributary streams contributed to the biological health at the Clark Fork station above Missoula, which was rated as only slightly impaired in 1997, and was unimpaired in 1998.

Below Missoula, biological integrity in the Clark Fork remained good to excellent during both 1997 and 1998. There was very little indication of increased sediment and nutrient impacts on the biota downstream of the Missoula urban area, Missoula's WWTP, and the Stone Container Corporation kraft mill. The Bitterroot River had good biological integrity during both 1997 and 1998, with only minor impairment of aquatic life indicated due to sediment.

The lower Clark Fork between the Bitterroot River and the Flathead River had good biological integrity, with little or no impairment indicated. The station downstream of the Flathead River was essentially unimpaired during August of both years.

Figure S1. Longitudinal trends - Mean biointegrity (%) of stream reaches in the Clark Fork Basin during August 1989 - 1998. Values are percent of total possible score, as the mean of impairment ratings (from 1 to 4) assigned to each data set over 10 years.



Stream reaches: SBC = Silver Bow Creek; CFR1 = Clark Fork from Warm Springs Creek to Little Blackfoot River; CFR2 = Clark Fork from Little Blackfoot River to Turah; CFR3 = Clark Fork from Blackfoot River to Bitterroot River; CFR4 = Clark Fork from Bitterroot River to Alberton; CFR5 = Clark Fork from Alberton to Flathead River

Longitudinal trends in mean biological integrity for stream reaches in the Clark Fork Basin over the ten years 1989-1998 are plotted in Figure S1. The biointegrity and subset values are the means of impairment rating scores assigned under bioassessment Protocol I (Bahls 1993), which uses ratings from 1 to 4, with 1 = severe impairment, 4 = no impairment. Values are expressed as a percentage of the maximum possible mean score of 4. Biointegrity is the mean of all three subset values. It is evident from the Figure S1 that biointegrity was poorest over the last ten years in the Silver Bow Creek reach and improved with distance downstream. The lower siltation index values generally depress biointegrity from the higher diversity and pollution index subsets.

Temporal trends are mean values for impairment rating scores in each subset and as a total of all subsets, again expressed as a percentage the maximum possible score of 4, determined sequentially over ten years for all Silver Bow Creek stations (Figure S2) and for all Clark Fork mainstem stations (Figure S3). Figure S2 shows relatively constant biointegrity at Silver Bow Creek stations, with a slight worsening trend indicated for the diversity index and pollution index subsets that appears to have reversed over the last five years. The siltation index subset for Silver Bow Creek shows a steady trend for improvement through the sequence. The Clark Fork mainstem stations (Figure S3) had very constant mean biointegrity through the sequence, with slight trends for improvement in the diversity and pollution index subsets, and a worsening of the siltation index subset.

Figure S2. Temporal trends - Mean sequential biointegrity (%) in Silver Bow Creek during 10 years of monitoring (1989-1998).

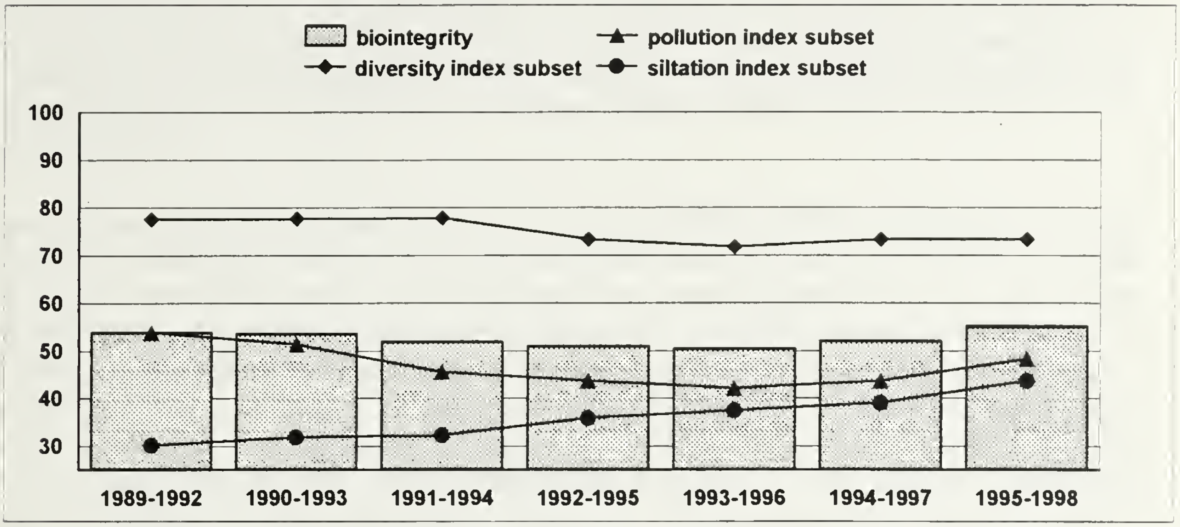
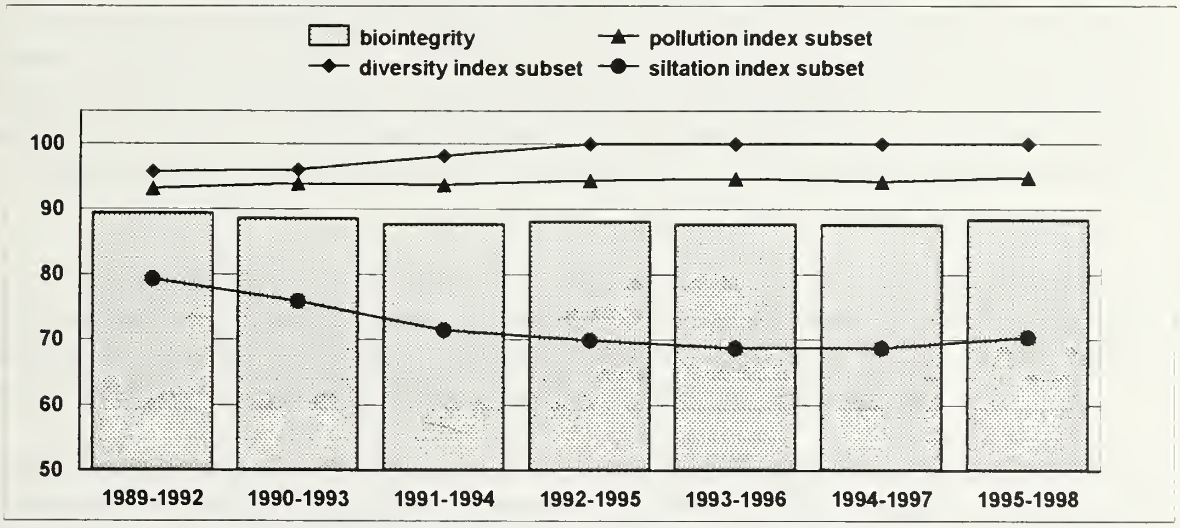


Figure S3. Temporal trends - Mean sequential biointegrity (%) in the Clark Fork during 10 years of monitoring (1989-1998).



INTRODUCTION

In August of 1997 and 1998, the Montana Department of Environmental Quality (DEQ) - Planning, Prevention and Assistance (PPA) Division contracted for benthic algae surveys to be conducted at 25 sites (27 sites in 1998) on the Clark Fork of the Columbia River and selected tributaries as part of the ongoing Clark Fork Basin Monitoring Project. Similar surveys have been conducted annually by DEQ (and its predecessor DHES) since 1986 (Bahls 1987 and 1989; Weber 1991, 1993, 1995, 1996, 1997 and 1998).

This report presents the results of analyses performed on periphyton samples collected during the 1997 and 1998 monitoring. Various metrics are employed to assess water quality and biological integrity at the stream sites surveyed. Longitudinal and temporal trends in water quality and biological integrity are also evaluated. Bahls (1993) states: "The concept of biological integrity is the basis for biological assessment and the setting of ecological goals for water quality." As defined by Karr and Dudley (1981): "Biological integrity is the ability of an aquatic ecosystem to support and maintain a ... community of organisms having species composition, diversity, and functional organization comparable to that of the natural habitats within a region." **This definition makes the explicit assumption that natural, undisturbed systems are better than those affected by human activities.**

Periphyton is the assemblage of small, often microscopic organisms (microinvertebrates, bacteria, fungi, and benthic algae) that occur in aquatic habitats, and live attached to or in close association with the surfaces of submerged substrates. Benthic algae typically dominate the periphyton community in freshwater streams. These algae can be divided into two major groups: diatom algae, which possess a rigid siliceous cell wall, or "frustule," and the non-diatom or soft-bodied algae, which lack a siliceous cell wall. The taxonomy of both groups has been well established. Because the shape and ornamentation of diatom frustules are unique to individual taxa, diatoms are readily identifiable down to the species level. It is generally impractical to identify non-diatom algae below the genus level.

Algae, and particularly the diatoms, are useful as biomonitors of water quality because they occur in very large numbers, are highly sensitive to physical and chemical factors, and have known environmental requirements and pollution tolerances unique to individual species (Bahls 1989). Plafkin et al. (1989) lists several other advantages of using algae for bioassessment:

- Algae generally have rapid reproduction rates and very short life cycles, making them valuable indicators of short-term impacts. (Perennial and fossil algae, including expired but recognizable algae within the periphyton matrix, reflect longer term impacts).

- As primary producers, algae are most directly affected by physical and chemical factors.

- Sampling is easy, inexpensive, requires few people, and creates minimal impact to resident biota.

- Relatively standard methods exist for evaluation of functional and non-taxonomic structural characteristics (e.g., biomass and chlorophyll) of algal communities.

- Algal communities are sensitive to some pollutants which may not visibly affect other aquatic communities, or may only affect other communities at higher concentrations (e.g., herbicides and inorganic nutrients).

Generally, periphyton collected from a particular stream location will reflect the environmental conditions that existed there for up to several weeks prior to sample collection. However, many factors in addition to water quality affect the types and amount of algae present at a given time. These include but are not necessarily limited to: streamflow extremes, substrate scour, variable recolonization rates, normal seasonal succession, and sloughing of algal biomass late in the season. Any bias introduced by factors not directly related to water quality can be minimized by sampling at the same time each year, well after the spring spate but before major sloughing of algal biomass occurs in late summer and early fall. Monitoring conducted during the month of August appears to satisfy the aforementioned criteria. Additionally, it likely encompasses the period of poorest seasonal water quality and maximum environmental stress on stream biota due to low streamflow, elevated water temperature, and minimum instream dilution of pollutants and wastewater discharges.

METHODS

Periphyton was collected at 25 monitoring stations on the Clark Fork and selected tributaries in 1997 (Table 1 and Figure 1). The 25 sites were identical to those monitored in 1996. Two mainstem stations discontinued in 1993 were reinstated in 1998, for a total of 27 monitoring locations in 1998 (Figure 1). These are station 08, Clark Fork near Dempsey and station 8.5, Clark Fork at Sager Lane (Table 1).

Sampling was conducted August 17 through 22, 1997 and August 12 through 16, 1998. A single composite periphyton sample was collected from natural substrates at each of the stations by contract personnel according to Procedure 6.2.2 (Periphyton) in the Water Quality Division's Field Procedure Manual (DHES 1989).

Each sample was processed and analyzed by the author in the following manner: A subsample of periphyton from each station was examined under an Olympus BHT compound microscope at 200X and 400X magnifications, and all soft-bodied (non-diatom) algae present were identified to genus. The relative abundance of cells belonging to each genus was estimated using the following system:

- R (Rare): Fewer than one cell per microscope field at 200X, on the average;

- C (Common): At least one, but fewer than five cells per field of view;

- VC (Very Common): Between 5 and 25 cells per field of view;

- A (Abundant): Greater than 25 cells per field of view, but numbers within limits reasonably counted;

- VA (Very Abundant): Number of cells per field too numerous to count.

The abundance of diatom algae (all genera collectively) relative to the non-diatom taxa was estimated for comparative purposes.

Non-diatom genera that ranked common or greater in estimate relative abundance were considered dominant taxa. Each dominant taxon, as well as the diatom component if it met this criterion, was ranked according to its estimated contribution to the total algal biovolume present in the sample. The taxon contributing the greatest biovolume was ranked number 1, the second most number 2, and so on. These rankings were used to calculate the dominant non-diatom phylum (see Non-Diatom Algae Metrics, below).

Following analysis of non-diatom algae, organic matter was chemically oxidized from each sample. A permanent strewn mount of the cleaned diatom frustules was prepared on a glass microscope slide according to "Standard Methods" (APHA et al. 1980). Each permanent mount was thoroughly

scanned under a 1000X, 1.25 N.A. oil immersion objective, and all diatom algae encountered identified to species. A proportional count of approximately 400 diatom frustules was performed on each permanent mount, and the percent relative abundance (PRA) of each diatom species was calculated. Diatom species identified during the floristic scan but not tallied during the proportional count were designated as present.

Each diatom species was assigned to one of the three pollution tolerance (PT) groups originally defined by Lange-Bertalot (1979). Simply stated, group 1 taxa are most tolerant of pollution, group 2 taxa less tolerant, and group 3 most sensitive to pollution. Bahls (1993) published expanded autecological criteria for assigning diatom taxa to PT groups, along with an extensive listing of diatom taxa reported from Montana. He also determined default PT group assignments, by genus, for taxa lacking sufficient autecological data. A number of unlisted taxa were assigned to PT groups by the author, based on updated autecological data in references by Krammer and Lange-Bertalot (1986, 1988, 1991a, 1991b) and Lange-Bertalot (1993). Default PT group assignments were used as a last resort.

Table 1. Periphyton sampling locations for Clark Fork Basin Project, August 1997 and 1998. Stations 08 and 8.5 were sampled in 1998 only.

station	stream and site name
SF-1	Blacktail Creek (BTC) above Grove Gulch
00	Silver Bow Creek (SBC) above Butte Metro Wastewater Treatment Plant (WWTP)
01	Silver Bow Creek below Colorado Tailings (and below Butte Metro WWTP)
2.5	Silver Bow Creek at Opportunity
4.5	Silver Bow Creek below Warm Springs Ponds
06	Warm Springs Creek (WSC) near mouth
07	Clark Fork (CFR) below Warm Springs Creek
08	Clark Fork near Dempsey
8.5	Clark Fork at Sager Lane
09	Clark Fork at Deer Lodge
10	Clark Fork above Little Blackfoot River
10.2	Little Blackfoot River (LBR) near mouth
11	Clark Fork at Gold Creek Bridge
11.5	Flint Creek (FTC) at New Chicago
11.7	Clark Fork at Bearmouth
12	Clark Fork at Bonita
12.5	Rock Creek (RKC) near Clinton
13	Clark Fork at Turah
14	Blackfoot River (BFR) at USGS Station near mouth
15.5	Clark Fork above Missoula
18	Clark Fork at Shuffields (and below Missoula WWTP)
19	Bitterroot River (BRR) near mouth
20	Clark Fork at Harper Bridge
22	Clark Fork at Huson (and below Stone Container Corporation)
24	Clark Fork near Superior
25	Clark Fork above Flathead River
27	Clark Fork above Thompson Falls Reservoir

Figure 1
Clark Fork Basin Monitoring Project

Non-Diatom Algae Metrics

Metrics applied to soft-bodied or non-diatom algae at each station include: **number of dominant genera**; **dominant phylum**; and, to a lesser extent, **indicator taxa**.

The **number of dominant non-diatom genera** is generally inversely proportional to the degree of pollution in western Montana streams. In least-impaired reference streams from mountain ecoregions in Montana, which included mountain valleys and foothills, Bahls (1993) reported from 1 to 10 (mean=5) dominant non-diatom genera. In pristine waters, low numbers of non-diatom genera generally indicate nutrient-poor conditions. Higher numbers of genera in unimpaired streams may indicate naturally higher levels of algal nutrients related to the mineralogical make-up of the local geology.

The **dominant non-diatom phylum** was determined by calculating the cumulative weighted rank of genera within each phylum based on estimated biovolume. Diatoms were not included in this metric. Briefly, in a sample with x number of dominant non-diatom genera, the genus ranking highest in estimated biovolume scored x points, second highest, x-1 points, and so on. The phylum having the greatest total points was considered dominant based on estimated relative biovolume. Green algae (phylum Chlorophyta) generally increase in abundance where the concentration of available nitrogen is sufficiently high relative to available phosphorus. Where nitrogen is in short supply, blue-green algae (phylum Cyanophyta) often dominate due to the ability of many the Cyanophyta to "fix" atmospheric nitrogen. Bahls et al. (1992) found that blue-green algae dominated the non-diatom flora of Northern Rockies reference streams, while green algae were co-dominant with blue-green algae in streams of the Montana Valley and Foothill Prairies ecoregion. The Clark Fork mainstem is considered to be primarily in the Montana Valley and Foothill Prairies ecoregion, as are the main reaches of tributary streams included in this monitoring.

Diatom Metrics

Metrics calculated for diatom associations at each station include **species richness**; the percent relative abundance (PRA) of the **dominant diatom taxon**; **Shannon diversity index**; **pollution index** and **siltation index**.

Species richness is a basic indicator of community health and as a rule correlates directly with water quality: as water quality declines, so does the number of species. In general, unpolluted waters in Montana have more than 25 diatom species counted (Bahls 1979). In reference streams from mountain ecoregions in Montana, between 23 and 51 (mean 33) diatom species were counted (Bahls et al. 1992).

The **Shannon diversity index** (Weber 1973) incorporates elements of species richness with equitability, the evenness of distribution of individuals among the species present. High diversity values occur in diatom communities where no taxa are strongly dominant in numbers, generally the case in healthy, unimpaired streams. In diatom communities under environmental stress, the majority

of individuals present belong to a relatively small number of taxa, resulting in lower diversity index values. In general, unpolluted waters in Montana have Shannon diversity values greater than 3.00 (Bahls 1979). Diatom species diversity values of between 2.16 and 4.50 (mean 3.58) were found in 21 least-impaired reference streams from mountain ecoregions (Bahls 1993).

The **pollution index** was proposed by Bahls (1993) as a shorthand method of summarizing the information contained in the three pollution tolerance groups of Lange-Bertalot (1979). The index is derived from the decimal fraction of the total PRA of diatom taxa in each pollution tolerance group, multiplied by the respective group number. The sum of these three products is the pollution index. The index will range from 1.00 (all most tolerant taxa) to 3.00 (all most sensitive taxa). Pollution index values of between 2.45 and 2.94 (mean 2.72) were determined by Bahls (1993) for diatom communities in reference streams from mountain ecoregions.

The **siltation index** is defined as the total percent relative abundance of species of *Navicula*, *Nitzschia* and *Surirella* diatoms present in a sample. These genera are comprised largely of highly motile, biraphidean diatoms that are better adapted to existence on unstable, shifting substrates. Values can range from 0 to 100; in mountain reference streams the index ranged from 0.0 to 50.3 (mean 14.5) (Bahls 1993).

Bioassessment Protocols

The two bioassessment protocols (I and II) were proposed by Bahls (1993) to assess **biological integrity** and aquatic life impairment in Montana streams. Only Protocol I was applied to diatom metrics calculated for Clark Fork Basin stream sites during 1997 and 1998.

Protocol I is used for screening purposes, generally when a local reference or control site is not available. It compares the Shannon diversity index, pollution index, and siltation index values from a study site to values from least-impaired reference streams located in the same physiographic province, or "ecoregion". Protocol I was developed with, and should only be used with, data collected during the summer months.

Under Protocol I, each index is given an individual rating and assigned a score based on a set of criteria (Table 5). Protocol I criteria for mountain streams were developed with data from 21 reference streams in the Northern Rockies, Middle Rockies, and the Montana Valley and Foothill Prairies ecoregions (Bahls et al. 1992). The criteria correspond to varying levels of environmental stress, pollution and siltation. The lowest score determines the overall biological integrity and impairment rating for the aquatic community at that station.

Protocol II, which compares diatom metrics values from a study site to values from a local upstream or sidestream reference site sampled at the same time, was not used to assess 1997 and 1998 data. A component of Protocol II is the **percent community similarity** (PCS) of Whittaker and Fairbanks (1958), which is the sum of the lower of the two PRA values for all diatom taxa that are in common between two samples. Relatively low PCS scores often resulted when comparing study and reference

sites located in different drainages. Because the lowest score established the overall biological integrity and impairment rating (as with Protocol I), ratings were often driven downward by the PCS. It is more likely that differences in diatom floras between Clark Fork and reference streams (such as Rock Creek or the Blackfoot River) is a natural condition, and not related to water quality degradation (Dr. Loren Bahls, pers.com.). For this reason Protocol II was not used for 1997 and 1998, but PCS values for adjacent sites on Silver Bow Creek and the Clark Fork mainstem will be used to assess change between sites.

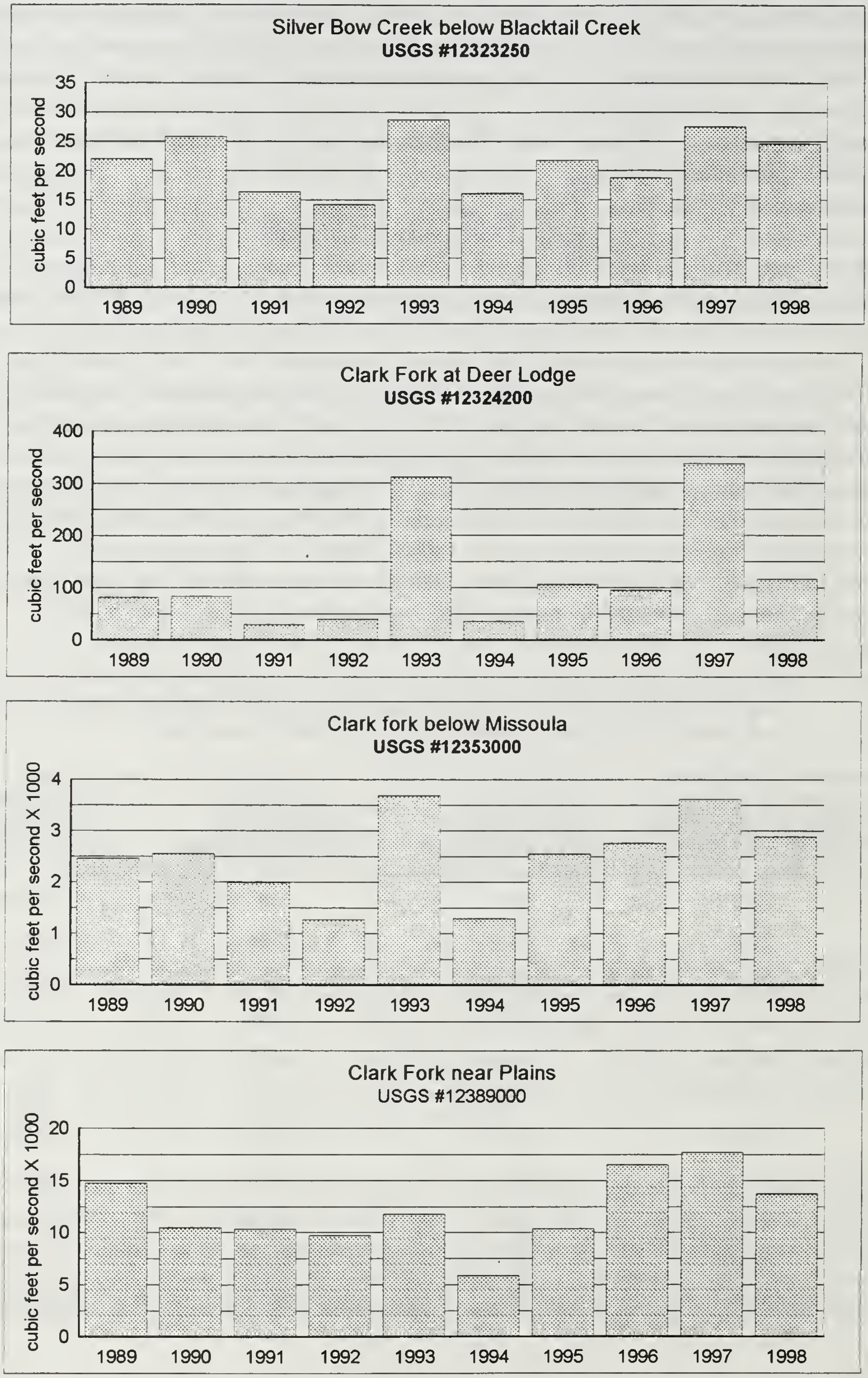
RESULTS AND DISCUSSION

Monthly mean streamflows at select USGS gaging stations in the Clark Fork Basin during August of the ten year period 1989-1998 are presented in Table 2 and Figure 2. Streamflows during August of 1997 were at or above the relatively high flows measured in 1996, and at two gaging stations eclipsed the record levels measured in 1993. Above-average precipitation in the Clark Fork basin during 1997 was responsible for sustaining high streamflows well into the summer months. The very high water levels at stream sites from Warm Springs Creek to the lower Clark Fork exacerbated sampling in 1997, and undoubtedly affected periphyton composition and standing crop at most locations. Streamflows were much lower during the 1998 sampling period, as reflected by August monthly means that were near the ten-year mean values (Table 2). Instream conditions in 1998 were much more conducive to algal growth and ease of sample collection than in 1997, and most mainstem Clark Fork reaches had substantially heavier algal standing crops in 1998 than in 1997.

Table 2. August monthly mean streamflows at selected USGS gaging stations in the Clark Fork Basin for the years 1989-1998 (cubic feet per second).

year	Silver Bow Creek below Blacktail Creek USGS # 12323250	Clark Fork at Deer Lodge USGS # 12324200	Clark Fork below Missoula USGS # 12353000	Clark Fork near Plains USGS # 12389000
1989	22.0	81.7	2464	14750
1990	25.8	84.3	2554	10510
1991	16.4	30.1	1997	10350
1992	14.2	40.1	1280	9738
1993	28.7	312	3696	11770
1994	16.1	36.3	1295	5891
1995	21.8	107	2561	10360
1996	18.7	95.2	2766	16530
1997	27.5	337	3620	17700
1998	24.6	117	2890	13700
mean	21.6	124	2512	12130

Figure 2. August monthly mean streamflows at selected USGS gaging stations in the Clark Fork Basin for the ten year period 1989-1998.



Non-Diatom Algae

The genera of non-diatom algae identified at each of the Clark Fork and tributary stations during 1997 and 1998 are listed by phylum in Appendices A and B respectively, along with estimated relative abundance and biovolume contribution rankings. Diatom algae (all genera considered collectively) are also included for comparison. The number of dominant non-diatom genera (those common or greater in estimated relative abundance) and the dominant phylum are presented in Table 3. Numbers of dominant non-diatom genera by phylum as green algae, blue-green algae and "other" (yellow-green, brown and red) algae for 1997 and 1998 are plotted in Figures 3 and 4, respectively.

In 1997, the number of dominant non-diatom algal genera present at the 25 Clark Fork and tributary stations ranged from 4 to 13 (mean 7.5). The **Clark Fork at Deer Lodge (station 09)** was the only station that had fewer than 5 non-diatom genera present (Table 3; Figure 3).

Green algae (phylum Chlorophyta) were dominant (based on estimated biovolume) at 19 of 25 stations in 1997, while blue-green algae (phylum Cyanophyta) were dominant at 5 stations, and yellow-green algae (phylum Chrysophyta) dominated the non-diatom flora at a single station (Table 3).

Blacktail Creek above Grove Gulch (station SF-1) had a diverse assemblage of eight pollution-sensitive non-diatom genera represented in 1997 (Figure 3; Appendix A). The three Silver Bow Creek stations upstream of the Warm Springs Ponds also had relatively high numbers of non-diatom taxa in 1997, with seven at **Silver Bow Creek above the Butte WWTP (station 00)**, six at **Silver Bow Creek below the Colorado Tailings (station 01)** and seven at **Silver Bow Creek at Opportunity (station 2.5)** (Table 3; Figure 3). The higher streamflows in 1997 appear to have had a positive effect on the number of non-diatom algae at these sites. However, a number of pollution-tolerant taxa such as *Stigeoclonium* and *Scenedesmus* that were not present in Blacktail Creek were dominant at the Silver Bow Creek sites (Table 3; Appendix A).

The **Clark Fork below Warm Springs Creek (station 07)**, supported a diverse group of eight dominant non-diatom genera in 1997, three more than were found just upstream in **Silver Bow Creek below Warm Springs Ponds (station 4.5)** and **Warm Springs Creek near mouth (station 06)** (Table 3; Figure 3). The number of non-diatom genera decreased to lows of four at the **Clark Fork at Deer Lodge (station 09)**, and five at the **Clark Fork above the Little Blackfoot River (station 10)**, but then rebounded significantly at the next eight mainstem Clark Fork stations below the Little Blackfoot River (Figure 3). Factors such as elevated sediment that are directly related to the high streamflows and poor streambank conditions in the Clark Fork reach upstream of the Little Blackfoot River probably had the greatest impact on non-diatom algae in that reach in 1997.

Of the eleven mainstem Clark Fork stations downstream of the Little Blackfoot River, ten had seven or more non-diatom genera in 1997. The **Clark Fork above Missoula (station 15.5)** had the greatest number of dominant taxa with ten, while the **Clark Fork near Superior (station 24)** had

only five genera present (Table 3; Figure 3). **Rock Creek near mouth (station 12.5)** and the **Blackfoot River near mouth (station 14)** lead all stations in 1997 with 12 and 13 dominant non-diatom taxa, respectively, suggesting that the high flows had relatively little effect on the periphyton community in these high quality tributaries (Figure 3).

In 1998, the number of non-diatom genera at the 27 monitoring stations ranged from 2 to 16 (mean 8.3). The only sites in 1998 with fewer than 5 non-diatom genera were **Silver Bow Creek above the Butte WWTP (station 00)** and **Silver Bow Creek below the Colorado Tailings (station 01)**, with 2 and 4 taxa, respectively (Table 3; Figure 4). These stations are in, or just below, the reach of Silver Bow Creek channel that was re-located and extensively re-contoured in 1998 as part of Superfund remedial activities at the former Colorado Tailings site.

Green algae dominated the algae present at 18 of the 27 stations monitored In 1998, and were co-dominant with blue-green algae at an additional 3 stations. Blue-green algae were dominant at 5 stations in 1998, while yellow-green algae dominated a single station (Table 3).

Blacktail Creek above Grove Gulch (station SF-1) again had a relatively diverse group of seven pollution sensitive non-diatom algae present in 1998 (Figure 4; Appendix B). As mentioned above, non-diatom taxa at the three Silver Bow Creek stations above the Warm Springs Ponds numbered between 2 and 5 in 1998, significantly lower than in 1997 (Table 3, Figure 4). Relatively tolerant non-diatom algae, including *Stigeoclonium* and *Scenedesmus*, once again replaced pollution-sensitive taxa found just upstream in Blacktail Creek (Appendix B). Elevated sediment related to the restructuring of the upper Silver Bow Creek channel, coupled with the increased impact of Butte's wastewater discharge as a consequence of lower streamflows, likely contributed to somewhat greater impairment of upper Silver Bow Creek in 1998.

Mainstem stations between Warm Springs Creek and the Little Blackfoot River in 1998 had from five to seven non-diatom taxa present in 1998 (Table 3; Figure 4). Included were two stations that were reinstated in 1998: the **Clark Fork near Dempsey (station 08)** and **Clark Fork at Sager Lane (station 8.5)**. These numbers are similar to those seen 1997, and likely indicate chronic impacts due to sediment, and possibly toxic metals associated with it.

The **Little Blackfoot River near mouth (station 10.2)** had 13 non-diatom taxa present in 1998, while the **Blackfoot River near mouth (station 14)** had 16 dominant taxa (Table 3; Figure 4). The latter was the highest number at any station in 1998. Non-diatom algae at all tributary and Clark Fork mainstem stations downstream of the Little Blackfoot River were quite numerous, with at least eight, and as many as 12 genera present. The general trend was for increased numbers of genera with distance downstream. The lower streamflows in 1998 particularly favored higher numbers of non-diatom algae at lower Clark Fork stations. Twelve genera of non-diatom algae were present in 1998 at the **Clark Fork above the Flathead River (station 25)**, while the fourteen genera present at the **Clark Fork above Thompson Falls Reservoir (station 27)** was double the number seen during the high flow year of 1997 (Table 3; Figure 4).

Diatom Algae

The estimated abundance of diatom algae (all genera considered collectively) relative to non-diatom algal genera at the 25 stations monitored in 1997 and the 27 stations monitored in 1998 are included in Appendices A and B, respectively. Diatoms are also ranked with non-diatom algal genera according to their estimated contribution to the total periphyton biovolume in each sample.

Diatoms were ranked at least "very common" in estimated abundance and were considered "dominant algae" at all 25 stations monitored in 1997 (Appendix A). Diatoms ranked first, second or third in estimated biovolume relative to non-diatom algae at 22 of the 25 stations monitored in 1997 (Appendix A).

In 1998, diatoms were ranked at least "very common" at 26 of 27 stations, with only a single station receiving a "common" ranking (Appendix B). Diatoms were considered "dominant algae" at all 27 stations monitored in 1998, and were ranked first, second or third in estimated biovolume at 25 of the 27 stations (Appendix B).

All diatom species identified during floristic scans and proportional counts are listed alphabetically in Appendix C for the 1997 monitoring, and in Appendix D for the 1998 monitoring. Percent relative abundance (PRA) values for all diatom species tallied during proportional counts are presented by station in Appendix C for 1997, and in Appendix D for 1998. Diatom species identified during the floristic scan, but not counted, are denoted as present. Lange-Bertalot pollution tolerance (PT) group assignments for each diatom species are also listed in Appendices C and D.

Values for diatom **species richness** at each station monitored during 1997 and 1998, along with the dominant diatom species and its corresponding PRA value, are listed in Table 3. The total percent relative abundance of diatom taxa in each of the three Lange-Bertalot pollution tolerance groups at each station are listed in Appendices C an D for 1997 and 1998, respectively.

Values for the **Shannon diversity index, pollution index and siltation index** calculated for each station during 1997 and 1998 are listed in Table 5, and are plotted in Figures 5, 6 and 7 for 1997 and in Figures 8, 9 and 10 for 1998. **Biological integrity** and **overall impairment of aquatic life** at each station, as determined by bioassessment **Protocol I** according to criteria in Table 6, are also listed in Table 5 for 1997 and 1998.

Percent community similarity values, calculated for adjacent stations on Silver Bow Creek and the Clark Fork mainstem, are plotted in Figures 11 and 12 for 1997 and 1998, respectively.

Diatom Species Richness

With the exception of two Silver Bow Creek stations, diatom species richness values at all Clark Fork and tributary stations in 1997 and 1998 were within the range of 23-51 species established by Bahls et al. (1992) for least-impaired reference streams from mountain ecoregions (Table 4). The lowest

diatom species richness values during both years were found in the reach of Silver Bow Creek above the Warm Springs Ponds. **Silver Bow Creek below the Colorado Tailings (station 01)** had the fewest diatom species of any station, with only 8 species tallied during both 1997 and 1998 (Table 4). **Silver Bow Creek at Opportunity (station 2.5)** was only slightly higher, with 10 and 11 diatom species in 1997 and 1998, respectively. The low values at station 01 can be contrasted against much higher species richness values just upstream at **Silver Bow Creek above the Butte WWTP (station 00)**, with 31 species in 1997 and 46 species in 1998, and at **Blacktail Creek above Grove Gulch (station SF-1)**, where there were 49 and 48 diatom species in 1997 and 1998, respectively (Table 4).

The highest species richness value at any of the 25 monitoring stations in 1997 was at **Blacktail Creek above Grove Gulch (station SF-1)** with 49, followed by **Clark Fork below Warm Springs Creek (station 07)** with 48 species, and **Silver Bow Creek below Warm Springs Ponds (station 4.5)**, where there were 45 diatom species tallied (Table 4).

The highest species richness value for the 27 stations monitored in 1998 was 49 at **Clark Fork below Warm Springs Creek (station 07)** and **Bitterroot River near mouth (station 19)**, followed by the 48 species counted at **Blacktail Creek above Grove Gulch (station SF-1)**.

Diversity Index

The Shannon diversity index fell within or exceeded the range of 2.16-4.50 determined for least-impaired reference streams at 23 of 25 stations monitored in 1997, and at 25 of 27 stations in 1998 (Table 5; Figures 5 and 8). The lowest Shannon diversity values during both 1997 and 1998 were at **Silver Bow Creek below Colorado Tailings (station 01)**, followed closely by **Silver Bow Creek at Opportunity (station 2.5)** (Table 5; Figures 5 and 8). By contrast, the diversity index values for **Blacktail Creek above Grove Gulch (station SF-1)** and **Silver Bow Creek below Warm Springs Ponds (station 4.5)** were among the four highest values measured in 1997 (Table 5; Figure 5). The diversity index value at **Silver Bow Creek above the Butte WWTP (station 00)** was the fifth highest measured in 1998, and was slightly higher than at **Blacktail Creek above Grove Gulch (station SF-1)** (Table 5; Figure 8)

The highest diversity index value in 1997 was at **Clark Fork below Warm Springs Creek (station 07)**, probably due at least in part to the high values immediately upstream at **Silver Bow Creek below Warm Springs Ponds (station 4.5)** and **Warm Springs Creek near mouth (station 06)** (Table 5; Figure 5). Diversity values dropped off sharply in 1997 at **Clark Fork at Deer Lodge (station 09)**, and remained less than 3.5 downstream to **Clark Fork at Gold Creek Bridge (station 11)** (Figure 5). Values at Clark Fork stations downstream to Missoula rebounded to about 4, possibly related to the similar, relatively high diversity values at every tributary station in this reach (Table 5; Figure 5). The **Clark Fork above Missoula (station 15.5)** had a diversity value of 4.22, one of the highest on the lower river in 1997, as did the **Bitterroot River near mouth (station 19)** (Figure 5). Diversity values at **Clark Fork at Shuffields (station 18)**, **Clark Fork at Harper Bridge (station 20)** and **Clark Fork at Huson (station 22)** decreased to 3 or less, suggesting problems in 1997 in this reach that receives waste discharges form both the City of Missoula WWTP

and the Stone Container Corporation pulp mill. Diversity recovered to a value above 4 at **Clark Fork at Superior (station 24)**, but dropped off again downstream to a low of about 3 at **Clark Fork above Thompson Falls Reservoir (station 27)** (Figure 5). This suggests the biota was under some stress in the lower river, possibly due to the sustained high flows seen in 1997.

In 1998, diversity index value were high in the upper Clark Fork. **Clark fork below Warm Springs Creek (station 07)** and the **Clark Fork above the Little Blackfoot River (station 10)** had the highest diversity of any sites in 1998 with values well above 4, and mainstem stations in between were only slightly lower (Figure 8). Diversity index values decreased sharply below the Little Blackfoot River, to less than 3 at **Clark Fork at Gold Creek Bridge (station 11), Clark Fork at Bearmouth (station 11.7), Clark Fork at Bonita (station 12)** and **Clark Fork at Turah** (Figure 8). Diversity values increased considerably from **Clark Fork above Missoula (station 15.5)** to **Clark Fork at Shuffields (station 18)**, and remained relatively high, although somewhat variable, in 1998 at all five Clark Fork stations downstream of Missoula (Figure 8). Tributary streams from **Flint Creek at New Chicago (station 11.5)** to the **Bitterroot River near mouth (station 19)** had diversity index values in 1998 that were consistently greater than 4 (Figure 8).

Pollution Index

Pollution index values in the Clark Fork Basin were within the range of 2.45-2.94 determined for least-impaired reference streams at 17 of 25 stations monitored during 1997, and at 21 of 27 stations monitored in 1998 (Table 5; Figures 6 and 9). The lowest values in both 1997 and 1998 were at **Silver Bow Creek below the Colorado Tailings (station 01)**, and were directly related to the Butte municipal wastewater discharge, and possibly the re-channelization of Silver Bow Creek in the area of the Colorado Tailings by the Superfund Program during both years (Table 5). Effects of channel re-construction were likely the cause, at least in part, of the moderately low pollution index value in 1997 at **Silver Bow Creek above the Butte WWTP (station 00)** (Figure 6). Relatively low values also occurred in 1997 at **Blacktail Creek above Grove Gulch (station SF-1)**, and downstream at **Silver Bow Creek below Warm Springs Ponds (station 4.5)** (Table 5; Figures 6 and 9). These may well have been related to periods high storm runoff during the summer of 1997.

Pollution index values at all Clark Fork and tributary sites downstream of the Warm Spring Ponds displayed a steady upward trend in both 1997 and 1998, and with no exceptions were high enough to warrant minor or better impairment scores (Table 5; Figures 6 and 9). The highest values in 1997 occurred at the three successive Clark Fork stations downstream of the Missoula WWTP discharge: **Clark Fork at Shuffields (station 18), Clark Fork at Harper Bridge (station 20)** and **Clark Fork at Huson (station 22)** (Figure 6). The lower end of this reach also receives wastewater from the Stone Container Corporation pulp mill. The high pollution index values at these sites did not indicate any serious pollution impacts in the Clark Fork related to municipal or industrial wastewater discharges, and may have been a beneficial effect of high, sustained streamflows in 1997.

The highest pollution index values seen in 1998 occurred in the middle Clark Fork reach downstream of the Little Blackfoot River, particularly at **Clark Fork at Gold Creek Bridge (station 11), Clark**

Fork at Bearmouth (station 11.7) and **Clark Fork at Bonita (station 12)** (Figure 9). However, pollution index values at these sites were only marginally higher than at several mainstem and tributary stations in the middle and lower reach of the Clark Fork Basin in 1998 (Table 5).

Siltation Index

The highest (and therefore poorest) siltation index value during both 1997 and 1998 occurred at **Silver Bow Creek below Colorado Tailings (station 01)** (Table 5; Figures 7 and 10). Siltation index values during 1997 were also very high at **Silver Bow Creek above the Butte WWTP (station 00)** and most upper and middle Clark Fork and tributary stations, particularly **Clark Fork at Deer Lodge (station 09), Clark Fork above the Little Blackfoot River (station 10),** and **Clark Fork at Gold Creek Bridge (station 11)** (Table 5; Figure 7). The high values throughout the upper Clark Fork Basin in 1997 are a direct result of storm water runoff from heavy thunder showers, and the effects of sustained high flows and poor streambank conditions. Two high-quality tributaries to the middle Clark Fork, **Rock Creek near mouth (station 12.5)** and **Blackfoot River near mouth (station 14)** had very low siltation index values in 1997, and the siltation index at nearly every Clark Fork station downstream of these streams was greatly reduced (Table 5, Figure 7).

In 1998, siltation index values were relatively high at Silver Bow Creek stations above the Warm Springs Ponds, at **Warm Springs Creek near mouth (station 06)**, and at all Clark Fork stations between Warm Springs Creek and the Little Blackfoot River, with the exception of **Clark Fork near Dempsey (station 08)** (Table 5; Figure 10). The **Little Blackfoot River near mouth (station 10.2)** had a relatively low siltation index value in 1998, particularly compared to 1997 (Table 5). All Clark Fork stations from the Little Blackfoot River to below Missoula had low siltation index values, with little or no impairment indicated in 1998 (Table 5; Figure 10). Siltation index values at **Clark Fork at Shuffields (station 18), Clark Fork at Huson (station 22)** and **Clark Fork at Superior (station 24)** were slightly elevated, suggesting the Missoula WWTP discharge and Stone Container Corporation may have had minor impacts on the Clark Fork in 1998 (Figure 10).

Individual Site Assessments

Each of the 25 mainstem and tributary stations sampled in August of 1997, and the 27 stations sampled in August of 1998 were rated for **biological integrity** and **overall impairment of aquatic life** under bioassessment Protocol I (Table 5). Criteria for Protocol I assessments are contained in Table 6. Percent community similarity of diatom floras at adjacent mainstem sites are plotted in Figures 11 and 12 for 1997 and 1998, respectively, and will be used to assess change between stations where possible. Temporal trends in the pollution index at each station are also examined.

Blacktail Creek above Grove Gulch (station SF-1)

Under bioassessment Protocol I, biological integrity at SF-1 in 1997 was rated as only fair, with moderate impairment of aquatic life indicated due to a slightly elevated siltation index value (Table 5). This was very likely due to the relatively high streamflows in 1997. In 1998 the siltation index was somewhat lower in Blacktail Creek, and biological integrity improved to a good rating, with only minor aquatic life impairment (Table 5).

Pollution index values at SF-1 for August of the years 1993-1998 are plotted in Figure 13. The 1997 value was the lowest seen for the period of record. While 1997 was a high flow year, there does not appear to be a strong correlation with average streamflow, as the highest pollution index values seen at SF-1 occurred during years of very high (1993) and very low (1994) flows in the upper Silver Bow Creek drainage (Figures 2 and 13). The 1998 pollution index value at SF-1 rebounded to about 1994 levels, reversing an apparent downward trend seen over the last three of four years (Figure 13).

Silver Bow Creek above Butte WWTP (station 00)

Biological integrity was rated as poor, with severe impairment of aquatic life at Silver Bow Creek station 00 in August 1997 under Protocol I due to a high siltation index value (Table 5). This site in 1997 was located in what proved to be a temporary, although well constructed channel that routed Silver Bow Creek through the Colorado Tailings area while the permanent stream course was being constructed. In 1998 station 00 was located in the new channel, which now has many of the attributes of a natural stream. The biological integrity improved slightly in 1998 to fair, with moderate impairment still indicated by the siltation index (Table 5). With the establishment of streambank vegetation and flushing of excess sediment from the new channel, it appears that upper Silver Bow Creek may be greatly improved in the near future.

The percent community similarity of diatom floras between station 00 and Blacktail Creek station SF-1 improved from a value indicating moderate change in 1997 (Figure 11) to no change in 1998 (Figure 12), suggesting very similar water quality.

Pollution index values for station 00 over the period 1989-1996 are plotted in Figure 14. The 1997 value improved considerably over the very low pollution index values seen during the previous two years, although moderate impairment was still indicated by this index. A major increase in pollution index was seen in 1998, that if considered alone would indicate only minor impairment of aquatic life in upper Silver Bow Creek. This improvement is directly attributable to the Superfund remedial efforts that are nearing completion along this reach of Silver Bow Creek.

Silver Bow Creek below Colorado Tailings (station 01)

Biological integrity was rated as poor, with severe overall impairment of aquatic life at Silver Bow Creek station 01 during both the 1997 and 1998 monitoring periods under Protocol I, with the pollution and siltation indexes receiving the lowest possible score of 1 during both years (Table 5). Moderate impairment was indicated by the diversity index values alone. The severe impairment of aquatic life indicated at Silver Bow Creek station 01 is the result of excessive biogenic waste loading from the Butte Metro wastewater treatment plant, along with toxic metals and sediments in the floodplain.

The very low percent community similarity between station 00 and station 01 for 1998 indicated much different water quality in Silver Bow Creek upstream and downstream of the Butte WWTP discharge and the Colorado Tailings site, a difference that was much less pronounced in 1997 (Figures 11 and 12).

Pollution index values at Silver Bow Creek station 01 over the ten years 1989-1998 are very low, and the 1998 value is the lowest for the period (Figure 15), clearly indicating that conditions have not improved in Silver Bow Creek below the Colorado Tailings.

Silver Bow Creek at Opportunity (station 2.5)

During August of both the 1997 and 1998 monitoring years, biological integrity at Silver Bow Creek station 2.5 was rated as fair, with moderate impairment of aquatic life indicated under bioassessment Protocol I (Table 5). A relatively low diversity index value in 1997, and a moderately high siltation index value in 1998 were the reasons for the fair ratings. All other indices for both years indicated only minor impairment at station 2.5.

Percent community similarity values between Silver Bow Creek stations 00 and 2.5 indicated somewhat similar floras in 1997 with only minor changes, while in 1998 the floras were less similar with moderate change indicated (Figures 11 and 12).

Pollution index values determined for station 2.5 since 1989 are plotted in Figure 16. Station 2.5, formerly known as station 03, and was relocated and renamed in 1992. The pollution index for 1997 was the value highest measured to date, and the 1998 was only slightly lower. Both 1997 and 1998 values indicate only minor impairment at station 2.5, a significant improvement over previous years and upstream station 00. Reasons for this improvement are not readily apparent.

Silver Bow Creek below Warm Springs Ponds

At Silver Bow Creek station 4.5, below the Warm Springs settling pond system, biological integrity was rated as fair during August 1997, with moderate impairment of aquatic life indicated under Protocol I due to a low pollution index value and an elevated siltation index value (Table 5). The siltation index at station 4.5 in 1997 was actually higher than at Silver Bow Creek station 2.5 upstream of the ponds (Figure 7). In 1998 the biological integrity was rated as good at station 4.5, with only minor aquatic life impairment indicated under Protocol I (Table 5).

Percent community similarity between station 4.5 and station 2.5 upstream of the Warm Springs Ponds were extremely low during both 1997 and 1998, indicating much different (and much improved) water quality downstream of the treatment ponds during both years (Figures 11 and 12).

Pollution index values for station 4.5 for the period 1989-1998 are plotted in Figure 17. The 1997 value was the lowest since 1991, while the 1998 pollution index value increased to about the same as in 1996. The Warm Springs Ponds serve to remove dissolved and sediment-born heavy metals from upper Silver Bow Creek. The impairment indicated by the relatively low pollution index value, and elevated siltation index value at station 4.5 in 1997 were likely related to frequent heavy thunderstorms and high streamflows that occurred in the Silver Bow Creek drainage area during the summer of 1997. These higher than normal flows may have reduced the pond system's treatment efficiency, causing increased sediment and/or heavy metals impacts at station 4.5, and possibly farther downstream. These impacts were not apparent in 1998, when streamflows were considerably lower (Figures 2, 7 and 10).

Warm Springs Creek near mouth (station 06)

Biological integrity at Warm Springs Creek station 06 during August of 1997 and 1998 was rated as only fair, with moderate impairment of aquatic life indicated under bioassessment Protocol I, due to elevated siltation index values (Table 5). Diversity and pollution index values for station 06 during both 1997 and 1998 received the highest rating of 4, indicating no impairment and much better conditions than suggested by the siltation index values. Although not readily apparent during the instream sampling, sediment contributions within the Warm Springs Creek drainage, which is lengthy and contains extremely diverse land uses, may be on the increase.

Pollution index values at Warm Springs Creek station 06, as already mentioned, were relatively high during both 1997 and 1998 (Figure 17), and indicated essentially no change in water quality over six or seven years.

Clark Fork reach 1 (CFR1)

Three upper Clark Fork stations comprised CFR1 in 1997: **Clark Fork below Warm Springs Creek (station 07), Clark Fork at Deer Lodge (station 09)** and **Clark Fork above the Little Blackfoot River (station 10)**. Station 07 was rated as having fair biological integrity with moderate aquatic life impairment in 1997 due to an elevated siltation index value (Table 5), and strongly resembled the two streams (Warm Springs Creek and Silver Bow Creek) that join to form the Clark Fork just upstream of station 07 (Table 5; Figures 5,6 and 7). Clark Fork station 09, at Deer Lodge and station 10, above the Little Blackfoot River were both ranked as severely impaired in 1997, with poor biological integrity due to high siltation index values (Table 5). However, diversity and pollution index values at these stations indicated little or no impairment at either site. The very high streamflows in the Clark Fork during August of 1997, combined with very poor streambank conditions throughout this reach undoubtedly contributed to the severe impairment rating.

The percent community similarity value between Clark Fork station 07 and Silver Bow Creek station 4.5 was quite high in 1997, indicating similar diatom floras and water quality (Figure 11). The value between Clark Fork stations 09 and 07 was considerably lower, indicating moderately different water quality downstream at Deer Lodge. The diatom floras at Clark Fork station 10, above the Little Blackfoot River was similar to that at Deer Lodge in 1997 (Figure 11).

Two Clark Fork stations were reinstated in 1998, five years after they were last monitored, and fall within CFR1. They are **Clark Fork near Dempsey (station 08)** and **Clark Fork at Sager Lane (station 8.5)** (Figure 1). In 1998, Clark Fork station 07 was rated as having only fair biological integrity with moderate impairment of aquatic life due to an elevated siltation index value, although the other metrics for station 07 returned ratings of good or excellent (Table 5). Station 08, only a few miles downstream, was rated as unimpaired, with excellent biological integrity in 1998. At Clark Fork stations 8.5, 09 and 10, slightly to moderately elevated siltation index values were measured in 1998 and were the only reason all three were rated as being moderately impaired (Table 5).

The percent community similarity between Clark Fork station 07 and Silver Bow Creek station 4.5, and between Clark Fork stations 08 and 07 indicated somewhat similar diatom communities in 1998, with only minor differences in water quality between these pairs of stations (Figure 12). A change in water quality of moderate magnitude was indicated by dissimilar diatom floras at Clark Fork stations 08 and 8.5, while a minor difference was seen between stations 8.5 and 09 (Figure 12). Clark Fork station 10, above the Little Blackfoot River and station 09, at Deer Lodge had very similar diatom communities, indicating little or no difference in water quality between these stations in August 1998 (Figure 12).

Pollution index values for the period 1989-1998 for the three stations included in CFR1 in 1997 are presented in Figures 19, 22 and 23. The two stations added to CFR1 in 1998 are presented in Figures 20 and 21. In 1997, pollution index values generally decreased down the reach, indicating a

worsening of water quality with distance form the headwaters. In 1998 values were quite high throughout CFR1, suggesting some improvement in water quality in this reach.

Little Blackfoot River near mouth (station 10.2)

In 1997, biological integrity at station 10.2 on the Little Blackfoot River was rated as fair, with moderate aquatic life impairment due to an elevated siltation index value, while in 1998 the rating improved to good, with only minor impairment indicated (Table 5).

Pollution index values at station 10.2 have been relatively stable, falling into either the unimpaired or minor impairment range over the six years the station has been monitored (Figure 24). The Little Blackfoot River appears to be an important tributary to the Clark Fork from the standpoint of contributing high quality water in a reach that suffers from significant water quality impairment.

Flint Creek at New Chicago (station 11.5)

Biological integrity at station 11.5 on was rated as fair during both 1997 and 1998 due to moderately elevated siltation index values (Table 5). Flint Creek has serious problems related to agriculture and poor streambank conditions that contribute to sediment problems in its lower reaches. Pollution index values at station 11.5 have shown little change over the six years since the station was established, and continue to fall just slightly under the level indicating excellent biological integrity and unimpaired aquatic life (Figure 26).

Clark Fork reach 2 (CFR2)

The four stations that comprise CFR2 include **Clark Fork at Gold Creek Bridge (station 11), Clark Fork at Bearmouth (station 11.7), Clark Fork at Bonita (station 12),** and **Clark Fork at at Turah (station 13)**. In 1997, station 11 was rated as having poor biological integrity, with severe impairment of aquatic due to a high siltation index value (Table 5). Station 11.7 and station 12 were rated as fair for biological integrity with moderate impairment, also for somewhat elevated siltation index values, while station 13 was rated as having good biological integrity with minor impairment in 1997 under Protocol I (Table 5).

In 1997, percent community similarity values between stations within Clark Fork reach 2, and between stations upstream and downstream of the reach were all in excess of 60%, indicating very similar diatom floras between stations, and relatively constant water quality without drastic changes through the reach (Figure 11).

Integrity and impairment ratings for CFR2 stations in 1998 were on a whole considerably higher than in 1997. This was particularly true of station 11, at gold Creek Bridge, which was rated as having

excellent biological integrity with no impairment of aquatic life (Table 5). Station 13, at Turah also rated as unimpaired, while stations 11.7 and 12 were rated as having good biological integrity with only minor impairment (Table 5).

The percent community similarity values between the Clark Fork Reach 2 stations in 1998 were all in excess of 75%, again indicating very constant conditions through this reach (Figure 12). This was also the case between the downstream end of the reach (station 12) and the adjacent mainstem station (station 15.5). The upstream end (station 11) was somewhat dissimilar from station 10, most likely a result of the Little Blackfoot River entering between the stations.

Pollution index values for stations 11, 12 and 13 for period 1989-1998 are plotted in Figures 25, 28 and 30 respectively, and for station 11.7 over the six years 1993-1998 in Figure 27. Values remained fairly high, generally above 2.5, for both 1997 and 1998, with a trend for slightly to moderately higher values in 1998. This was likely a result of the high sustained flows in 1997, compared to the lower flows measured in 1998. None of the Clark Fork reach 2 stations appeared to suffer from appreciable pollution stress in 1997 or 1998.

Rock Creek near Clinton (station 12.5)

Rock Creek station 12.5 was rated as having excellent biological integrity in 1997, with no impairment of aquatic life indicated under Protocol I (Table 5). In 1998, station 12 received a biological integrity rating of good, with minor impairment indicated due to a very slightly elevated siltaton index value (Table 5). The credibility of this lower rating might be questioned, based on the unimpaired ratings returned for station 12.5 by the other diatom metrics in 1998. Pollution index values for station 12 over the six monitoring years are consistently high, reflecting the dependably high water quality in Rock Creek (Figure 29).

Blackfoot River at USGS Station near mouth (station 14)

The Blackfoot River station 14 was rated as unimpaired, with excellent biological integrity both 1997 and 1998 under bioassessment Protocol I during (Table 5). Pollution index values for the ten years that ended in 1998 were very stable and well above 2.5, indicating consistently high-quality, unpolluted water in this important major tributary to the Clark Fork .

Clark Fork reach 3 (CFR3)

The **Clark Fork above Missoula (station 15.5)**, and the **Clark Fork at Shuffields (station 18)** make up reach CFR3. Station 15.5 was rated as having good biological integrity with only minor impairment of aquatic life in 1997, and was unimpaired with excellent biological integrity in 1998 under Protocol I (Table 5). Station 18 at Shuffields was rated a having good biological integrity with minor aquatic life impairment during both 1997 and 1998 (Table 5). This minor impairment was due only to siltation index values that were slightly to moderately elevated, most notably during the lower flows of 1998 (Figure 10).

Percent community similarity between station 15.5 and upstream Clark Fork station 13 was about 80% for both 1997 and 1998, which is very high and indicates essentially unchanged water quality despite the Blackfoot River entering between the two Clark Fork sites. Percent similarity between diatom floras at station 15.5 and station 18 were lower during both years, and indicated a minor change in water quality between stations. These stations bracket the "urban"reach of river through Missoula and the Missoula WWTP discharge to the Clark Fork, both of which are likely to influence water quality.

Pollution index values for station 15.5 above Missoula were very constant over the ten year period from 1989 to 1998 (Figure 32), and indicated generally unimpaired water quality in the Clark Fork just below the Blackfoot River and Milltown Dam. At station 18, pollution index values were slightly more variable over the ten years, but were essentially of the same magnitude as at station 15.5 (Figure 33). As mentioned above, Missoula's WWTP discharge and non-point sources of sediment from the urban corridor through Missoula are probable factors affecting this station.

Bitterroot River near mouth (station 19)

Bitterroot River station 19 was rated as having good biological integrity with minor aquatic life impairment during August of both 1997 and 1998 under Protocol I, due once again to very slightly elevated siltation index values (Table 5). Pollution index values at station 19 have been somewhat variable since the low in 1993 and the high in 1995, but appear to have stabilized over the last three years (Figure 34). This large tributary continues to have a positive impact on water quality in the Clark Fork.

Clark Fork reach 4 (CFR4)

The **Clark Fork at Harper Bridge (station 20)**, and the **Clark Fork at Huson (station 22)** are included in reach CFR4. Both stations were rated "unimpaired" with excellent biological integrity in 1997, and as having good biological integrity with only minor impairment of aquatic life in 1998

under Protocol I (Table 5). The minor impairment in 1998 was due to slightly elevated siltation index values.

Community similarity between Clark Fork stations 20 and 22 was 80% in 1997, indicating no change in water quality between these sites (Figure 11). In 1998 the value was somewhat lower, but indicated little, if any change between the two stations in CFR4 (Figure 12). Station 20 was also very similar to upstream station 18 during both 1997 and 1998.

Pollution index values at Harper Bridge station 20 over the period 1989-1995 have fluctuated slightly but have remained well above 2.5 (Figure 35). The values measured in 1997 and 1998 were the highest in at least four years. Station 22 at Huson has displayed a somewhat greater variability over ten years, with the 1997 value the highest measured, and the 1998 value near the lowest (Figure 36).

Clark Fork reach 5 (CFR5)

The **Clark Fork near Superior (station 24)**, and **Clark fork above the Flathead River (station 25)** comprise reach CFR5. Biological integrity at both stations was rated as good, with minor impairment of aquatic life under Protocol I during both 1997 and 1998, due to very slightly elevated siltation index values (Table 5).

Percent community similarity between stations 24 and 25 was quite high during both 1997 and 1998, indicating there was little change in water quality through this reach (figures 11 and 12). Station 24 was somewhat less similar to upstream station 22 during both 1997 and 1998, indicating a minor change in water quality.

Pollution index values at Clark Fork station 24 have remained quite high over the period 1989-1998, but may be exhibiting a slight downward trend over the last three years, from a high measured in 1995 (Figure 37). Values for pollution index at station 25 have been very high for the last four years, following low values between 1992 and 1994 (Figure 38). All indications are that the lower Clark Fork enjoys very good water quality, and that the biota is largely unimpaired.

Clark Fork above Thompson Falls Reservoir (station 27)

Biological integrity at Clark Fork station 27, above Thompson Falls Reservoir, was rated as excellent, with no aquatic life impairment during August 1997 under Protocol I (Table 5). The siltation index value at station 27 in 1997 was the lowest measured at any Clark Fork Basin station. In 1998 the biological integrity was rated as good, with only minor impairment of aquatic life indicated at station 27, again due to a very slightly elevated siltation index value (Table 5). The pollution index at station 27 over the period 1989-1998, while somewhat variable, has generally exceeded 2.5, indicating unpolluted conditions in this very large river (Figure 39).

Longitudinal Trend Assessments

Pollution index values for August 1997, and mean values for August 1989-1997 at 19 stations on Blacktail Creek, Silver Bow Creek and the Clark Fork mainstem are plotted in Figure 40. The 1997 data for Blacktail Creek station SF-1 and Silver Bow Creek stations 00 and 01 fell slightly below the long-term mean plot, and suggest a pollution impact in the headwaters of Silver Bow Creek during August 1997. Silver Bow Creek station 2.5, located above the Warm Springs Ponds, had a pollution index value much higher than the ten year average in 1997, while the opposite was true of station 4.5, downstream of the ponds. The pollution index value at Clark Fork station 07 was slightly greater than the long-term value, while the next seven Clark Fork stations down to station 15.5 above Missoula all fell at, or slightly below the long-term mean. From station 18 at Shuffields to station 22 at Huson, values for 1997 again exceeded the mean, while from station 24 at Superior to lower Clark Fork station 27 the pollution index was basically at the mean value. Pollution index values at most Clark Fork stations during August 1996. followed the nine-year longitudinal trend quite closely.

Pollution index data for August 1997 at selected Clark Fork Basin tributary stations are plotted in Figure 41, along with mean values for August over the period 1989-1997. Included is the “mainstem” headwater tributary Blacktail Creek station SF-1 and Silver Bow Creek station 4.5, below the Warm Springs Ponds. With the exception of stations SF-1 and station 4.5, the tributary streams had pollution index values that were at, or very near the nine year average in 1997.

Mean pollution index values for selected reaches on Silver Bow Creek and the Clark Fork mainstem for August of 1997 and August 1989-1997 are plotted in Figure 42. The steam reach approach aides in interpreting the data by effectively grouping sites within familiar boundaries. The mean value for pollution index in the Silver Bow Creek (SBC) reach (stations 00, 01 and 2.5) for 1997 was slightly above the long-term average, due largely to the high value at station 2.5. This suggests a slight decrease in pollution in the Silver Bow Creek reach as a whole in 1997, although the improvement was largely at a single station. The 1997 pollution index values were very near the long-term mean at at least three of the five Clark Fork reaches. Reach CFR2 (stations 11, 11.7, 12 and 13) was slightly better than average, as was CFR4 (stations 20 an 22) (Figure 42).

Pollution index values for August 1998, and mean values for August of 1989-1998 (fewer years for several stations) at 21 mainstem stations on Blacktail Creek, Silver Bow Creek and the Clark Fork mainstem, including two stations reinstated in 1998, are plotted in Figure 43. In the headwaters, Blacktail Creek station SF-1 was very near the long-term mean, as was Silver Bow Creek station 4.5 below the Warm Springs Ponds. Silver Bow Creek stations 00 and 2.5 were well above average in 1998, while station 01 was below the long-term mean to about the same degree. With the exception of Clark Fork stations 08, 09 and 11, which were above average, the majority of Clark Fork stations had pollution index values in 1998 at or very near the long-term mean values (Figure 43).

Pollution index data for August 1998 at selected Clark Fork Basin tributary stations are plotted in Figure 44, along with mean values for August over the period 1989-1998. Blacktail Creek SF-1 and Silver Bow Creek station 4.5 were at the ten-year mean value, while Warm Springs Creek and the

Little Blackfoot River were slightly above average in 1998. The remaining four stream stations, including Flint Creek, Rock Creek, the Blackfoot River and the Bitterroot River had pollution index values in 1998 that were very near to the long-term mean (Figure 44).

Mean pollution index values for selected reaches on Silver Bow Creek and the Clark Fork mainstem for August of 1998 and August 1989-1998 are plotted in Figure 45. The mean value for pollution index in the Silver Bow Creek (SBC) reach (stations 00, 01 and 2.5) was slightly above the mean, while reach CFR1 was very much above the long term mean due to the addition of station 08, near Dempsey and station 8.5, at Sager Lane. The remainder of the Clark Fork reaches in 1998 had pollution index values that were very near the long-term mean (Figure 45).

Table 3. Summary of non-diatom algae in periphyton samples from the Clark Fork and tributaries during August 1997 and 1998.

	number of dominant taxa[1]		dominant non-diatom phylum[2]	
station	1997	1998	1997	1998
SF-1	8	7	Chlorophyta	Chlorophyta
00	7	2	Chlorophyta	Chrysophyta
01	6	4	Chlorophyta	Chlorophyta
2.5	7	6	Chlorophyta	Chlorophyta
4.5	5	6	Chlorophyta	Chlorophyta
06	5	5	Chrysophyta	Cyanophyta
07	8	7	Chlorophyta	Cyanophyta
08	-	5	-	Chlor/Cyan
8.5	-	6	-	Chlorophyta
09	4	5	Cyanophyta	Chlorophyta
10	5	6	Cyanophyta	Chlorophyta
10.2	8	13	Chlorophyta	Chlor/Cyan
11	7	9	Chlorophyta	Cyanophyta
11.5	5	9	Cyanophyta	Cyanophyta
11.7	8	9	Chlorophyta	Chlorophyta
12	8	8	Chlorophyta	Chlorophyta
12.5	12	8	Cyanophyta	Cyanophyta
13	8	8	Chlorophyta	Chlorophyta
14	13	16	Chlorophyta	Chlorophyta
15.5	10	11	Cyanophyta	Chlor/Cyan
18	8	10	Chlorophyta	Chlorophyta
19	8	9	Chlorophyta	Chlorophyta
20	9	10	Chlorophyta	Chlorophyta
22	8	10	Chlorophyta	Chlorophyta
24	5	9	Chlorophyta	Chlorophyta
25	8	12	Chlorophyta	Chlorophyta
27	7	14	Chlorophyta	Chlorophyta

[1]Dominant taxa are those common or greater in estimated relative abundance; see Appendices A and B.

[2]Dominant non-diatom phylum based on total estimated biovolume contribution of dominant genera in each phylum.

Table 4. Summary of diatom algae in periphyton samples from the Clark Fork and tributaries during August 1997 and 1998.

	species richness		dominant diatom taxon[1] (percent relative abundance)			
station	1997	1998	1997		1998	
SF-1	49	48	*Nitzschia dissipata*	(13.63)	*Fragilaria construens*	(19.68)
00	31	46	*Navicula minima*	(22.86)	*Fragilaria construens*	(21.67)
01	8	8	*Navicula atomus*	(63.10)	*Navicula atomus*	(67.87)
2.5	10	11	*Achnanthes minutissima*	(62.62)	*Achnanthes minutissima*	(47.02)
4.5	45	38	*Nitzschia paleacea*	(17.65)	*Nitzschia paleacea*	(15.85)
06	38	42	*Achnanthes minutissima*	(26.41)	*Cymbella silesiaca*	(19.09)
07	48	49	*Achnanthes minutissima*	(9.25)	*Navicula cryptotenella*	(13.26)
08	-	36	-	-	*Cocconeis placentula*	(31.97)
8.5	-	40	-	-	*Navicula cryptotenella*	(13.44)
09	29	41	*Nitzschia inconspicua*	(31.53)	*Epithemia sorex*	(25.67)
10	29	42	*Nitzschia dissipata*	(37.50)	*Navicula cryptotenella*	(11.30)
10.2	37	29	*Nitzschia archibaldii*	(16.35)	*Epithemia sorex*	(32.60)
11	28	32	*Nitzschia dissipata*	(27.80)	*Epithemia sorex*	(60.14)
11.5	40	33	*Nitzschia dissipata*	(15.38)	*Navicula capitatoradiata*	(16.91)
11.7	32	33	*Nitzschia dissipata*	(20.69)	*Epithemia sorex*	(54.28)
12	30	31	*Nitzschia dissipata*	(17.26)	*Epithemia sorex*	(53.25)
12.5	36	38	*Epithemia sorex*	(28.40)	*Achnanthes minutissima*	(23.22)
13	34	23	*Epithemia sorex*	16.27)	*Epithemia sorex*	(63.86)
14	34	33	*Achnanthes minutissima*	(22.89)	*Epithemia sorex*	(24.69)
15.5	37	37	*Nitzschia paleacea*	(14.43)	*Epithemia sorex*	(52.76)
18	32	34	*Cymbella affinis*	(42.79)	*Epithemia sorex*	(12.01)
19	44	49	*Achnanthes minutissima*	(17.31)	*Achnanthes minutissima*	(19.76)
20	28	30	*Cymbella turgidula*	(34.45)	*Cymbella affinis*	(36.98)
22	24	42	*Cymbella affinis*	(39.71)	*Epithemia sorex*	(19.02)
24	35	35	*Cymbella affinis*	(12.03)	*Epithemia sorex*	(19.95)
25	26	36	*Cymbella turgidula*	(26.79)	*Epithemia sorex*	(34.13)
27	28	43	*Cymbella affinis*	(30.88)	*Achnanthes minutissima*	(19.91)

[1]Taxon with greatest percent relative abundance (value in parentheses).

Table 5. Diatom association metrics, and biological integrity and overall impairment of aquatic life ratings at monitoring stations on the Clark Fork and tributaries during August 1997 and 1998 under bioassessment Protocol I.

	diversity index (score)		pollution index (score)		siltation index (score)		low score		biological integrity		overall impairment	
station	1997	**1998**	1997	**1998**	1997	**1998**	1997	**1998**	1997	**1998**	1997	**1998**
SF-1	4.46 (4)	**4.26 (4)**	2.01 (3)	**2.33 (3)**	37.71 (2)	**28.38 (3)**	2	**3**	fair	**good**	moderate	**minor**
00	3.69 (4)	**4.33 (4)**	1.62 (2)	**2.10 (3)**	61.90 (1)	**48.57 (2)**	1	**2**	poor	**fair**	severe	**moderate**
01	1.51 (2)	**1.40 (2)**	1.29 (1)	**1.08 (1)**	85.71 (1)	**90.41 (1)**	1	**1**	poor	**poor**	severe	**severe**
2.5	1.61 (2)	**1.88 (3)**	2.26 (3)	**2.01 (3)**	35.95 (3)	**51.55 (2)**	2	**2**	fair	**fair**	moderate	**moderate**
4.5	4.70 (4)	**4.12 (4)**	2.00 (2)	**2.17 (3)**	55.39 (2)	**30.77 (3)**	2	**3**	fair	**good**	moderate	**minor**
06	4.12 (4)	**4.17 (4)**	2.56 (4)	**2.71 (4)**	43.77 (2)	**39.86 (2)**	2	**2**	fair	**fair**	moderate	**moderate**
07	4.85 (4)	**4.55 (4)**	2.47 (3)	**2.48 (3)**	45.50 (2)	**41.86 (2)**	2	**2**	fair	**fair**	moderate	**moderate**
08	-	**3.56 (4)**	-	**2.75 (4)**	-	**18.75 (4)**	-	**4**	-	**excellent**	-	**none**
8.5	-	**4.22 (4)**	-	**2.54 (4)**	-	**58.02 (2)**	-	**2**	-	**fair**	-	**moderate**
09	3.42 (4)	**4.26 (4)**	2.14 (3)	**2.57 (4)**	74.82 (1)	**42.86 (2)**	1	**2**	poor	**fair**	severe	**moderate**
10	3.25 (4)	**4.65 (4)**	2.35 (3)	**2.33 (3)**	82.31 (1)	**59.13 (2)**	1	**2**	poor	**fair**	severe	**moderate**
10.2	4.25 (4)	**3.47 (4)**	2.46 (3)	**2.77 (4)**	50.24 (2)	**27.45 (3)**	2	**3**	fair	**good**	moderate	**minor**
11	3.35 (4)	**2.72 (4)**	2.43 (3)	**2.83 (4)**	77.34 (1)	**19.32 (4)**	1	**4**	poor	**excellent**	severe	**none**
11.5	4.51 (4)	**4.09 (4)**	2.46 (3)	**2.49 (3)**	59.80 (2)	**59.31 (2)**	2	**2**	fair	**fair**	moderate	**moderate**
11.7	3.93 (4)	**2.94 (4)**	2.66 (4)	**2.81 (4)**	49.01 (2)	**20.78 (3)**	2	**3**	fair	**good**	moderate	**minor**
12	3.98 (4)	**2.97 (4)**	2.56 (4)	**2.75 (4)**	52.01 (2)	**24.58 (3)**	2	**3**	fair	**good**	moderate	**minor**
12.5	3.76 (4)	**4.11 (4)**	2.77 (4)	**2.64 (4)**	17.23 (4)	**25.59 (3)**	4	**3**	excellent	**good**	none	**minor**
13	3.85 (4)	**2.33 (4)**	2.66 (4)	**2.83 (4)**	37.32 (3)	**14.70 (4)**	3	**4**	good	**excellent**	minor	**none**
14	3.91 (4)	**3.91 (4)**	2.80 (4)	**2.66 (4)**	15.42 (4)	**17.85 (4)**	4	**4**	excellent	**excellent**	none	**none**
15.5	4.22 (4)	**3.12 (4)**	2.62 (4)	**2.78 (4)**	37.90 (3)	**22.30 (4)**	3	**4**	good	**excellent**	minor	**none**
18	3.15 (4)	**4.32 (4)**	2.83 (4)	**2.67 (4)**	22.84 (3)	**38.97 (3)**	3	**3**	good	**good**	minor	**minor**
19	4.30 (4)	**4.29 (4)**	2.57 (4)	**2.65 (4)**	33.41 (3)	**21.20 (3)**	3	**3**	good	**good**	minor	**minor**
20	3.08 (4)	**3.60 (4)**	2.82 (4)	**2.78 (4)**	18.66 (4)	**25.79 (3)**	4	**3**	excellent	**good**	none	**minor**
22	2.79 (4)	**4.37 (4)**	2.84 (4)	**2.58 (4)**	16.22 (4)	**38.29 (3)**	4	**3**	excellent	**good**	none	**minor**
24	4.31 (4)	**4.27 (4)**	2.68 (4)	**2.62 (4)**	35.38 (3)	**36.78 (3)**	3	**3**	good	**good**	minor	**minor**
25	3.68 (4)	**3.67 (4)**	2.75 (4)	**2.77 (4)**	25.84 (3)	**23.80 (3)**	3	**3**	good	**good**	minor	**minor**
27	3.15 (4)	**4.35 (4)**	2.73 (4)	**2.62 (4)**	7.13 (4)	**22.25 (3)**	4	**3**	excellent	**good**	none	**minor**

Table 6. Criteria for establishing impairment ratings and scores for diatom association metrics from mountain streams under bioassessment Protocol I (Bahls 1993).

score	rating	diversity index	pollution index	siltation index
1	high stress	<1.00		
	severe pollution		<1.50	
	heavy siltation			>60
2	moderate stress	1.00-1.75		
	moderate pollution		1.50-2.00	
	moderate siltation			40-60
3	minor stress	1.76-2.50		
	minor pollution		2.01-2.50	
	minor siltation			20-39
4	no stress	>2.50		
	no pollution		>2.50	
	no siltation			<20

lowest score	biological integrity	overall impairment
1	poor	severe
2	fair	moderate
3	good	minor
4	excellent	none

Figure 3. Number of dominant non-diatom algae genera at Clark Fork and tributary stations during August 1997.

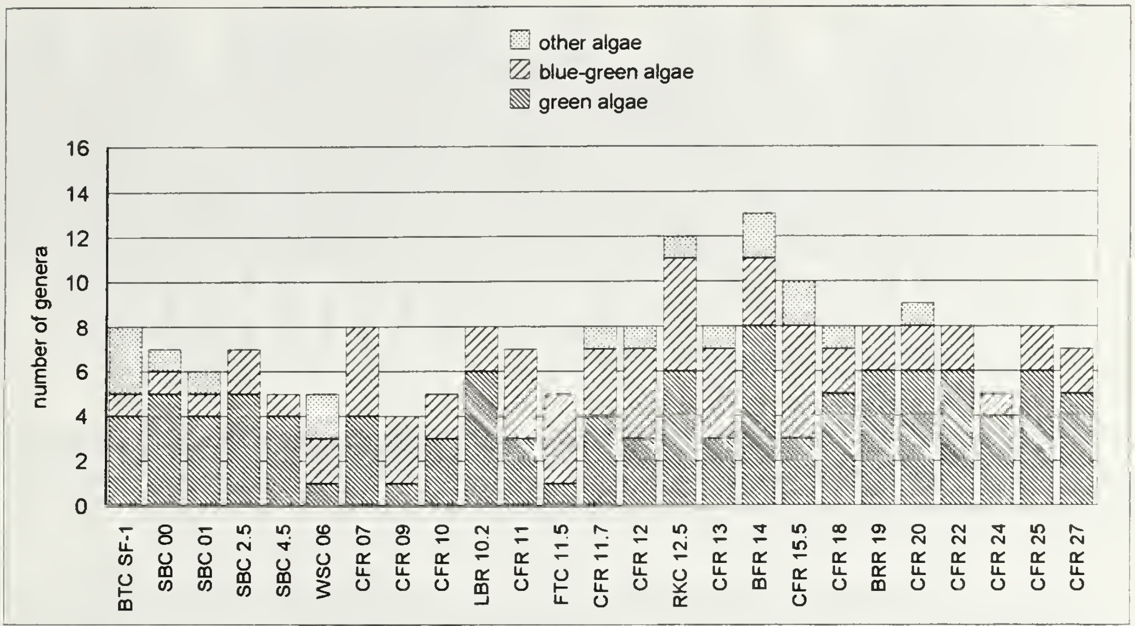


Figure 4. Number of dominant non-diatom algae genera at Clark Fork and tributary stations during August 1998.

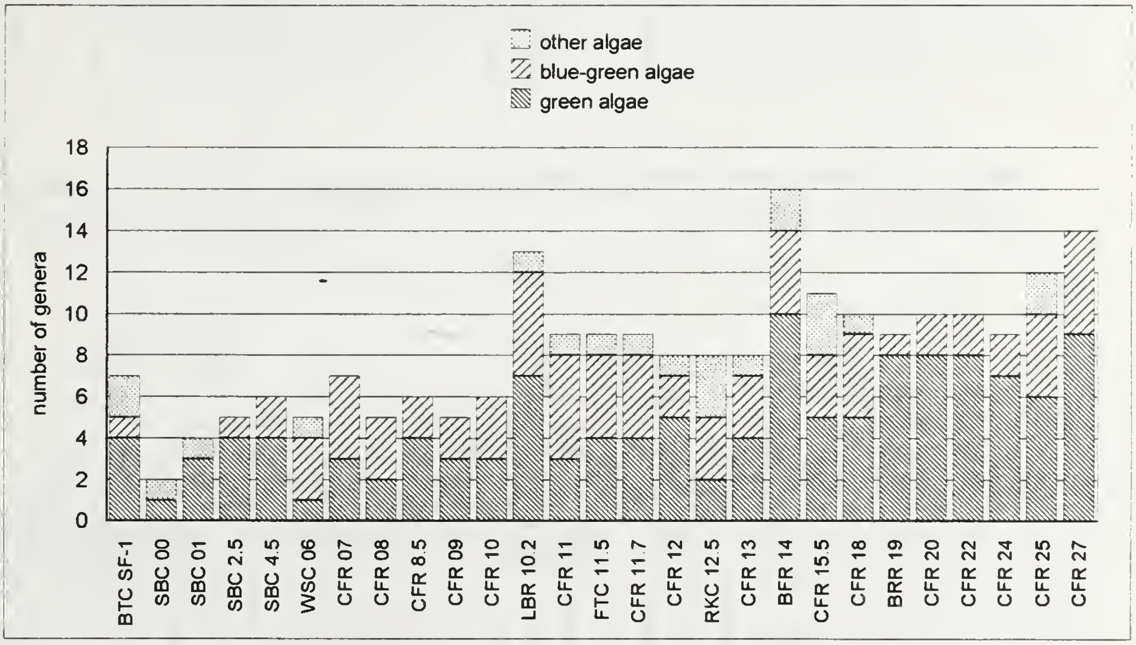


Figure 5. Shannon diversity index values for diatom associations from the Clark Fork and tributaries during August 1997.

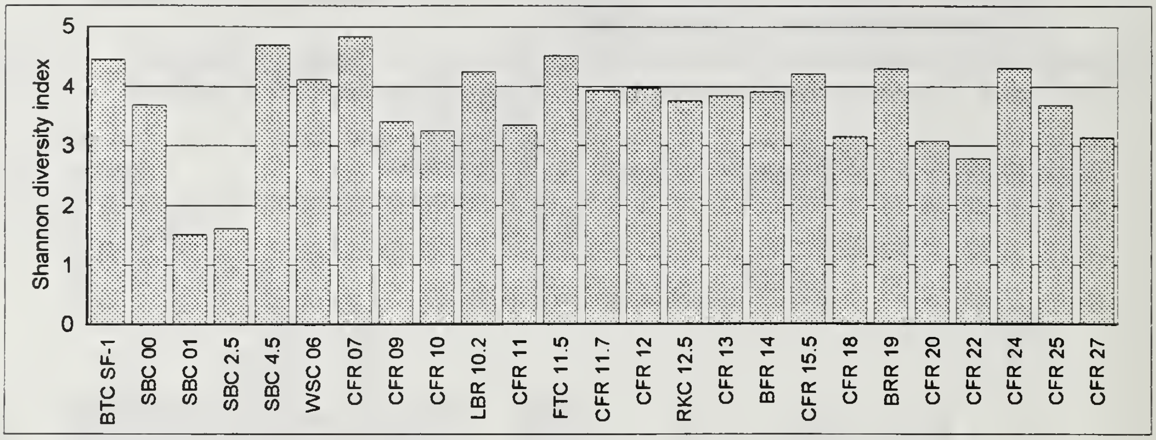


Figure 6. Pollution index values for diatom associations from the Clark Fork and tributaries during August 1997.

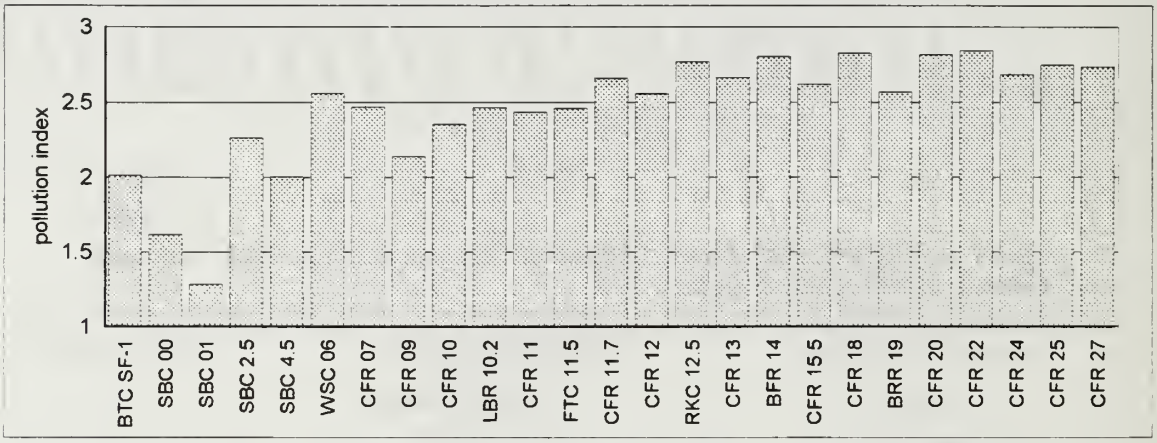


Figure 7. Siltation index values for diatom associations from the Clark Fork and tributaries during August 1997.

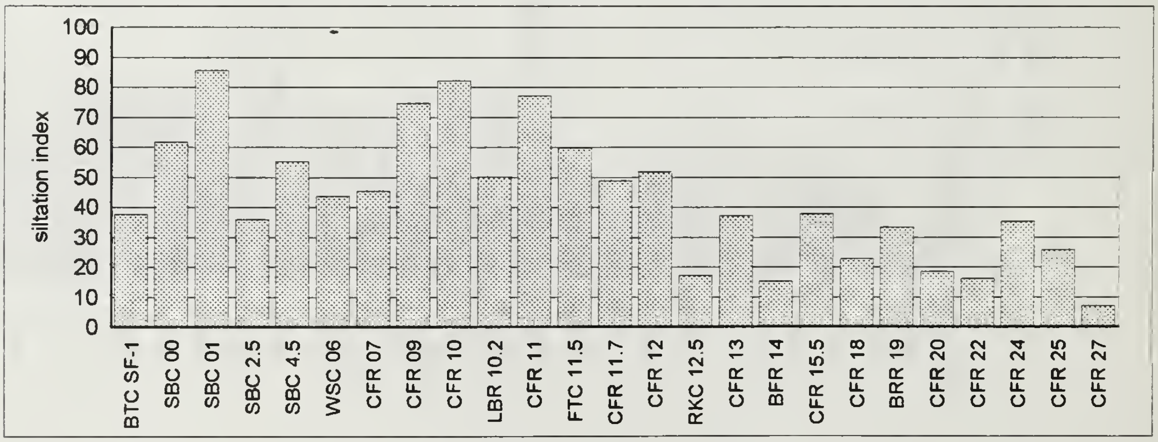


Figure 8. Shannon diversity index values for diatom associations from the Clark Fork and tributaries during August 1998.

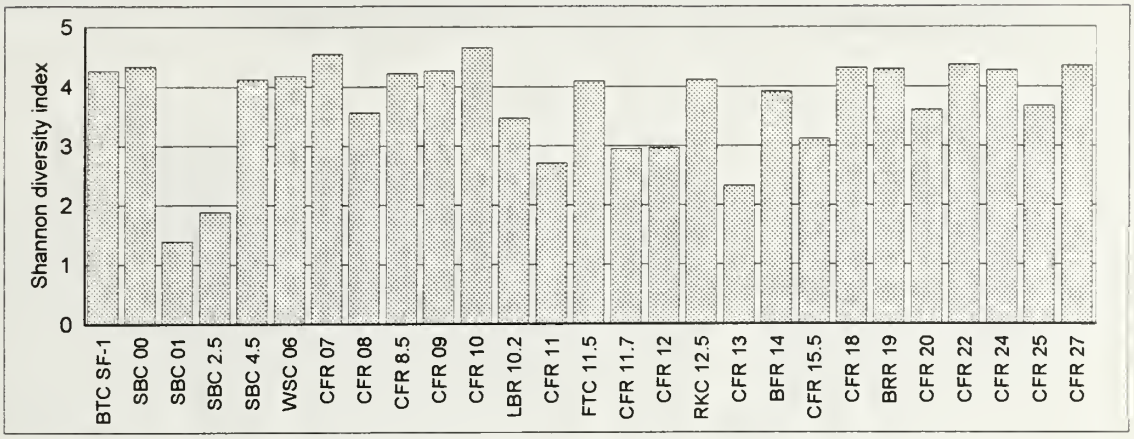


Figure 9. Pollution index values for diatom associations from the Clark Fork and tributaries during August 1998.

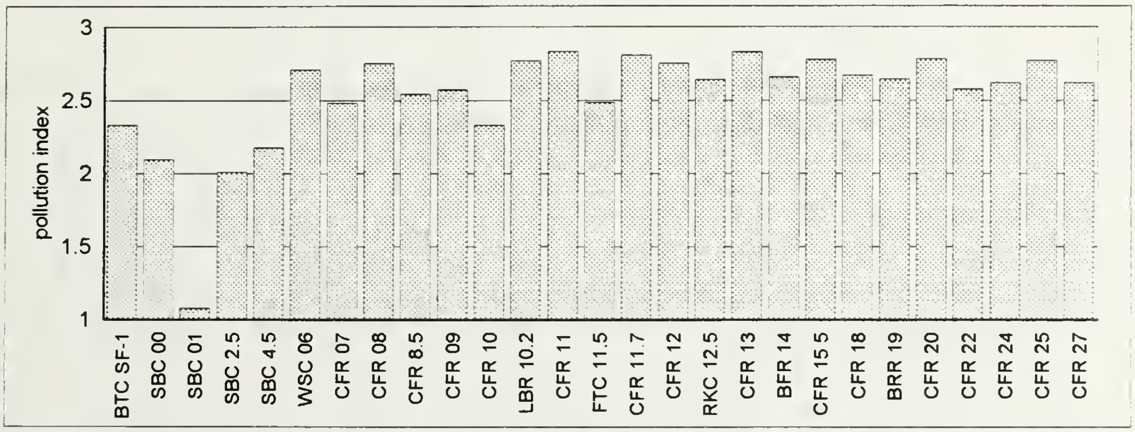


Figure 10. Siltation index values for diatom associations from the Clark Fork and tributaries during August 1998.

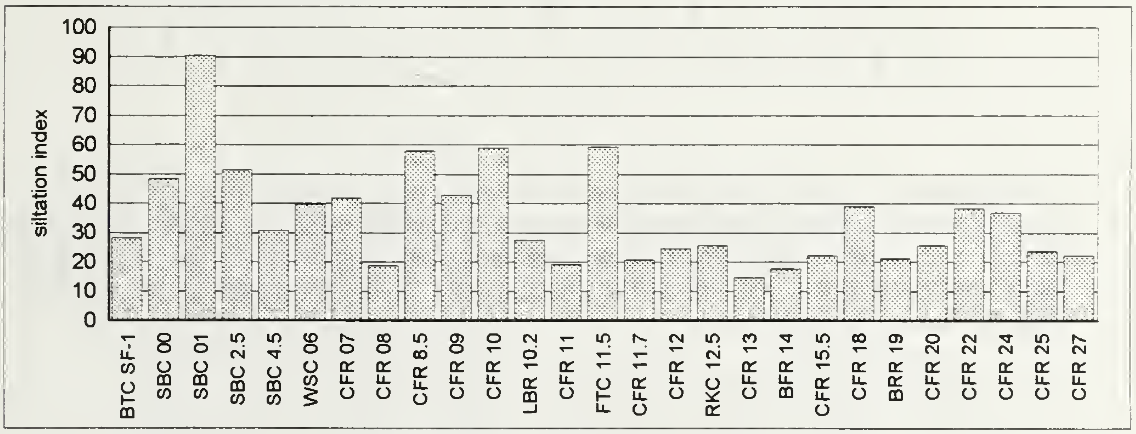


Figure 11. Percent community similarity[1] of diatom floras between adjacent mainstem Silver Bow Creek and Clark Fork stations during August 1997.

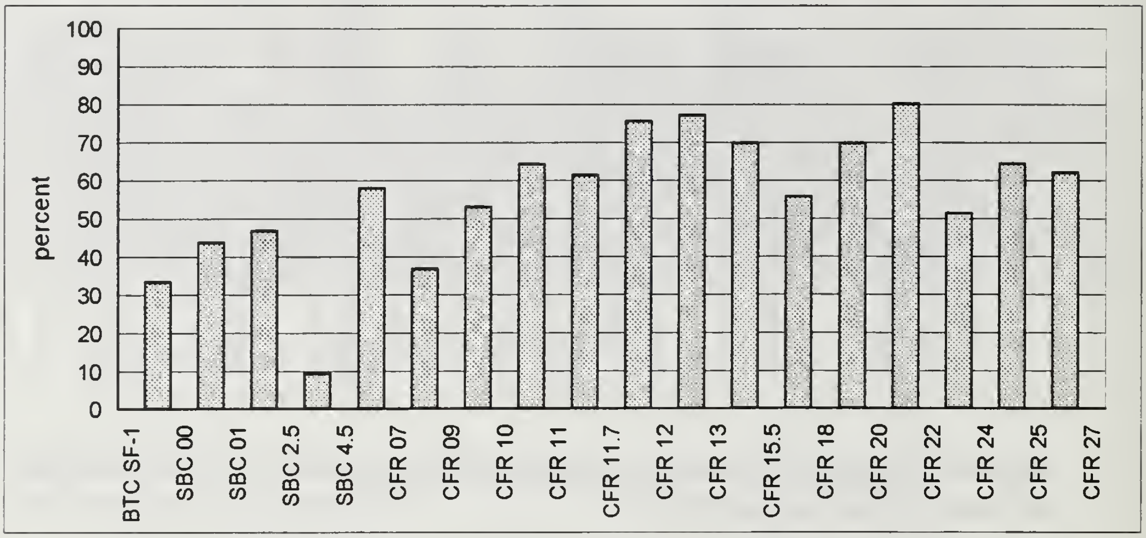
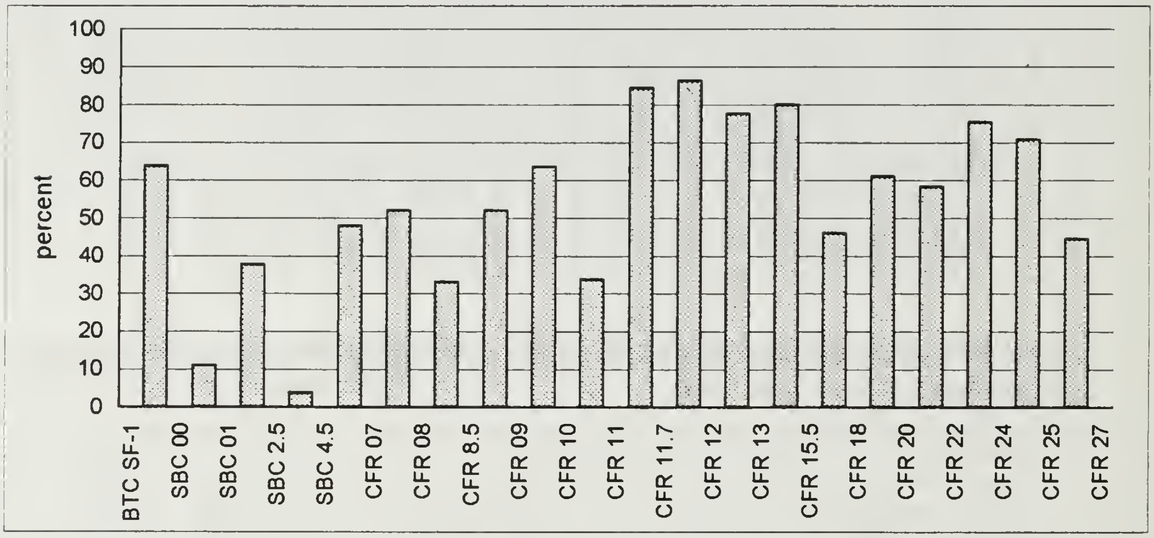


Figure 12. Percent community similarity[1] of diatom floras between adjacent mainstem Silver Bow Creek and Clark Fork stations during August 1998.



[1] The percent community similarity may be used to gauge the relative amount of impairment or recovery that occurs between adjacent study sites: >59.9% = very similar floras, no change; 40.0-59.9% = somewhat similar floras, minor change; 20.0-39.9% = somewhat dissimilar floras, moderate change; <20.0% = very dissimilar floras, major change (Bahls 1993).

Figure 13. Pollution index values for Blacktail Creek above Grove Gulch (station SF-1), 1993-1998.

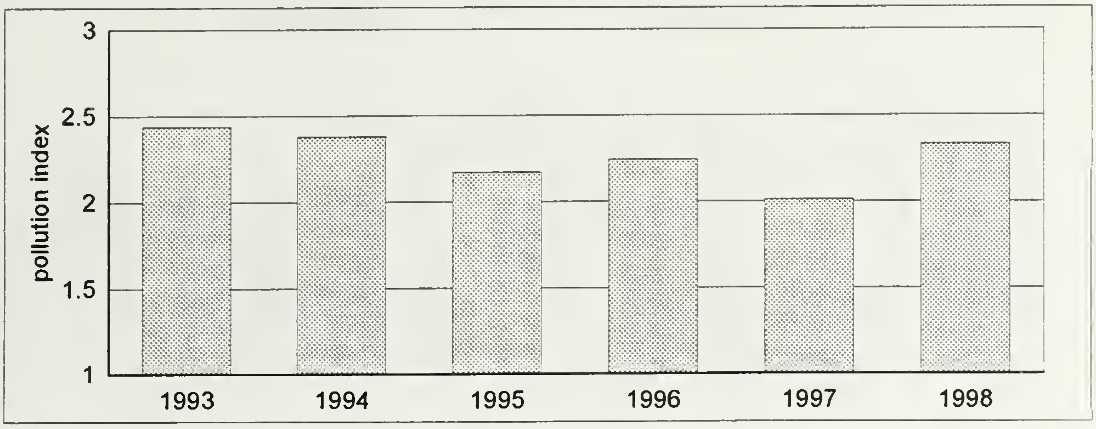


Figure 14. Pollution index values for Silver Bow Creek above the Butte WWTP (station 00), 1989-1998.

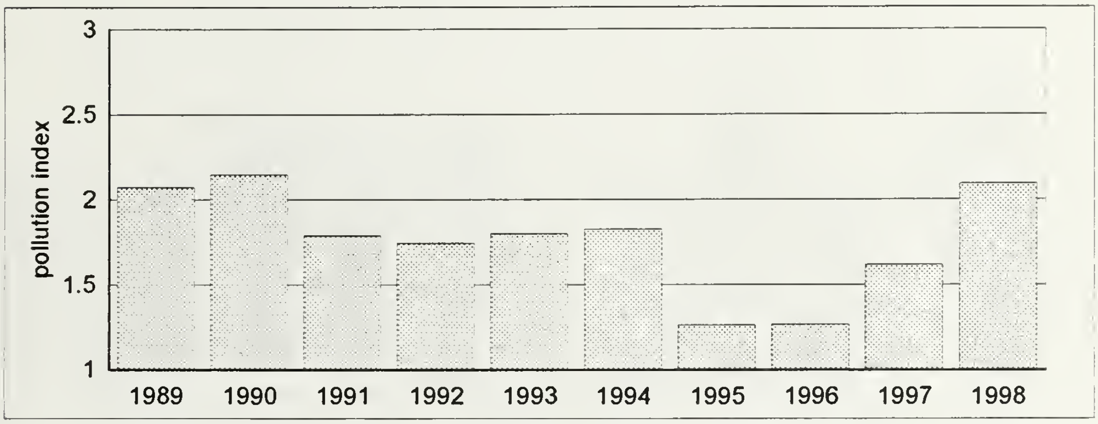


Figure 15. Pollution index values for Silver Bow Creek below the Colorado Tailings (station 01), 1989-1998.

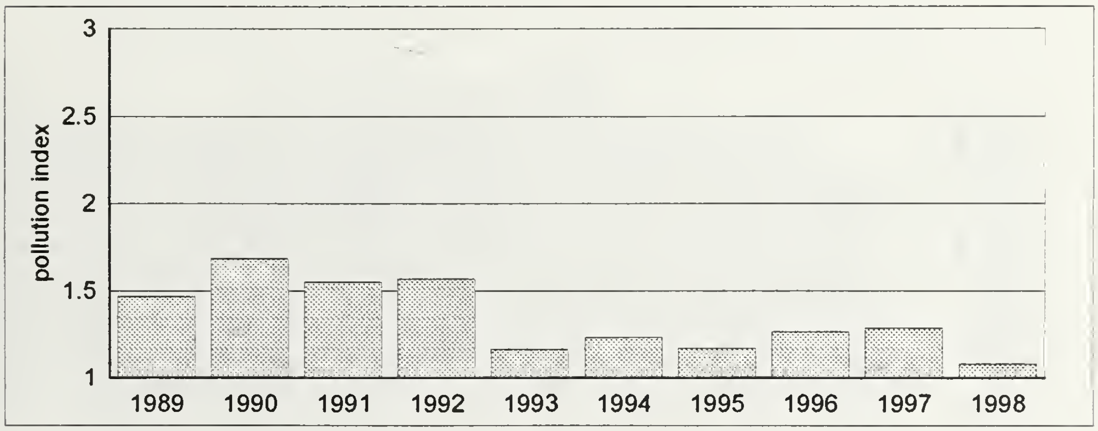


Figure 16. Pollution index values for Silver Bow Creek at Opportunity (station 2.5), 1989-1998. (station 03, 1989-91; not sampled in 1992).

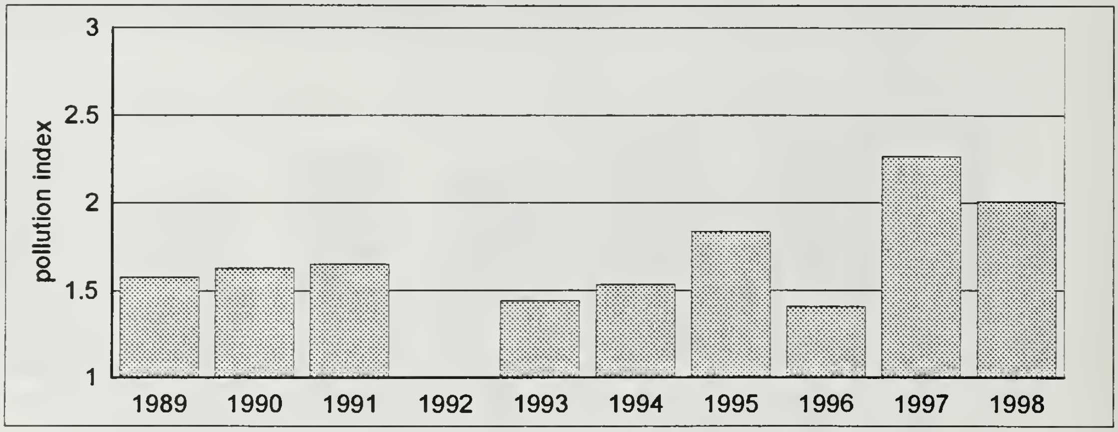


Figure 17. Pollution index values for Silver Bow Creek below Warms Springs Ponds (station 4.5), 1989-1998. (station 04, 1989-91; not sampled in 1992).

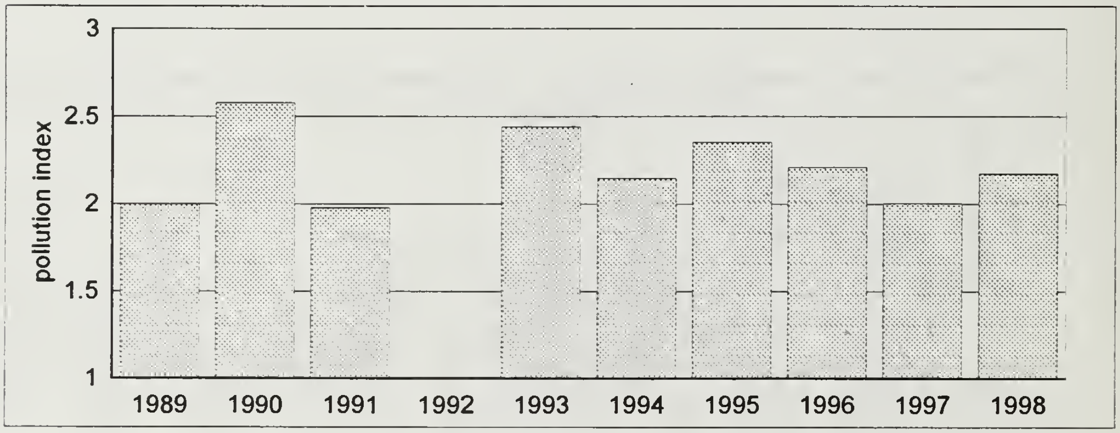


Figure 18. Pollution index values for Warm Springs Creek near mouth (station 06), 1989-1998.

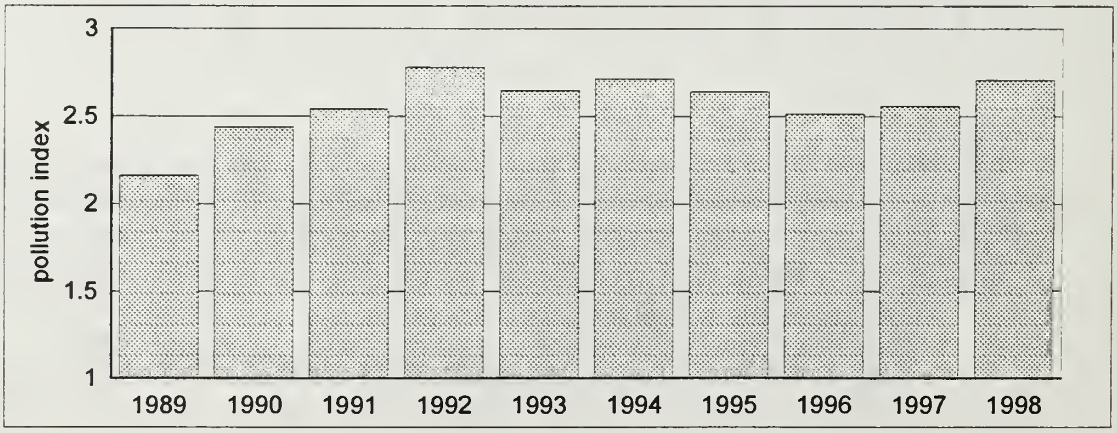


Figure 19. Pollution index values for Clark Fork below Warm Springs Creek (station 07), 1989-1998.

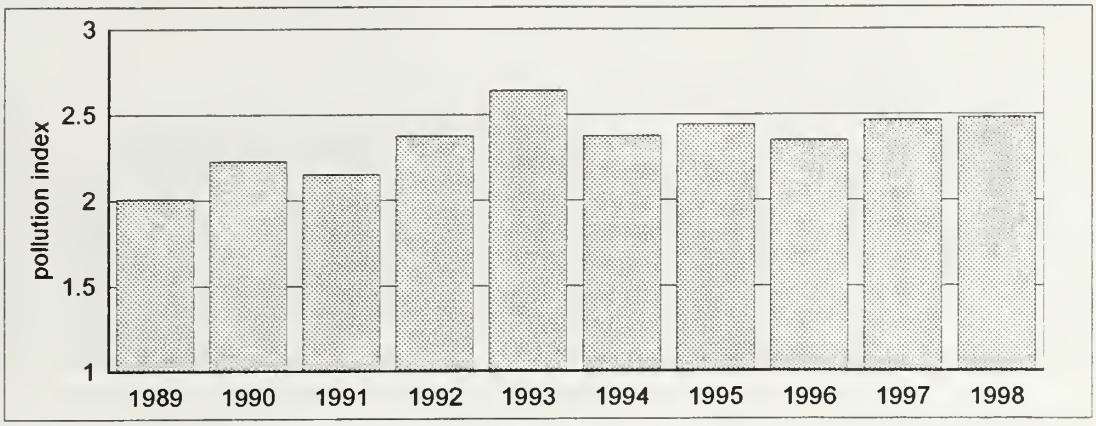


Figure 20. Pollution index values for Clark Fork at Dempsey (station 08), 1989-1998; (not sampled in 1993-1997).

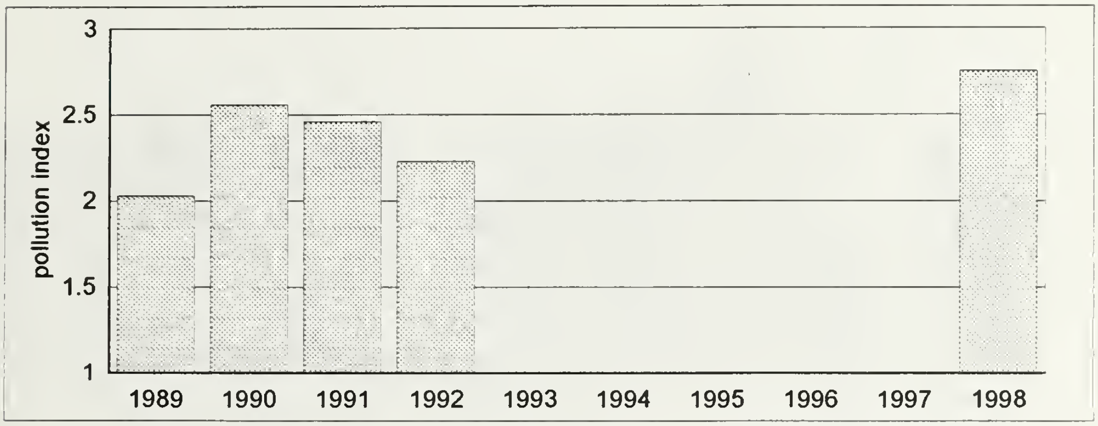


Figure 21. Pollution index values for Clark Fork at Sager Lane (station 8.5), 1989-1998; (not sampled 1989, 1993-1997).

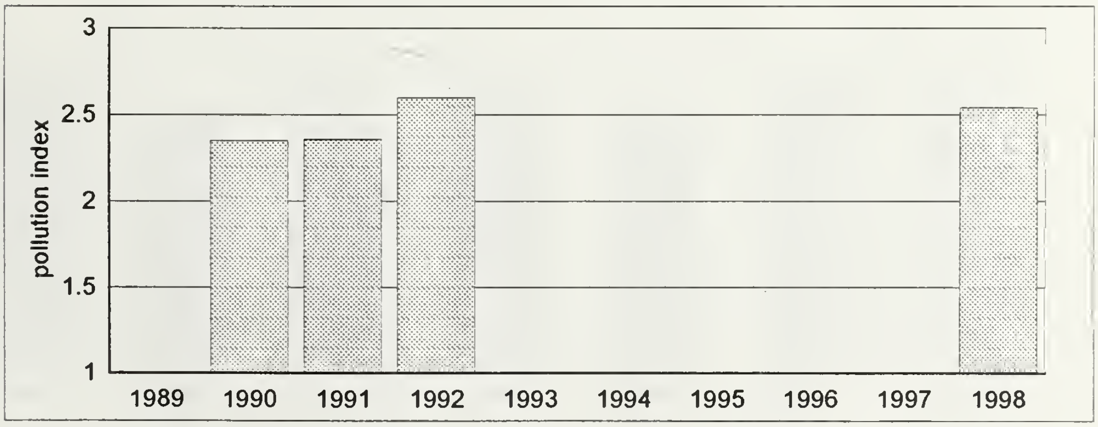


Figure 22. Pollution index values for Clark Fork at Deer Lodge (station 09), 1989-1998.

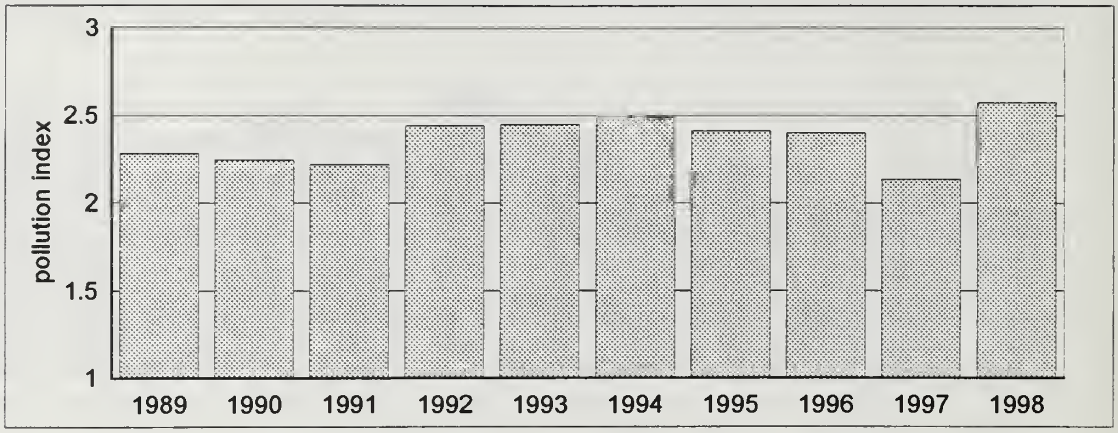


Figure 23. Pollution index values for Clark Fork above the Little Blackfoot River (station 10), 1989-1998.

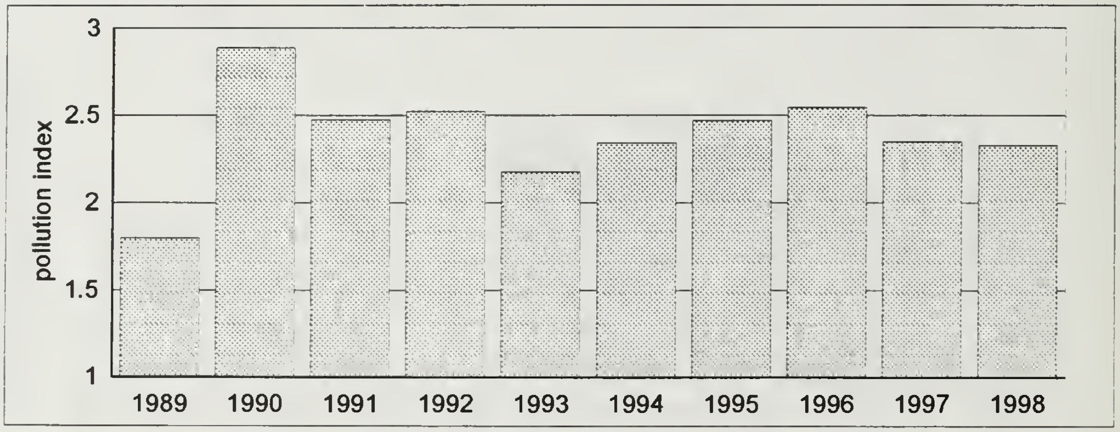


Figure 24. Pollution index values for Little Blackfoot River near mouth (station 10.2), 1993-1998.

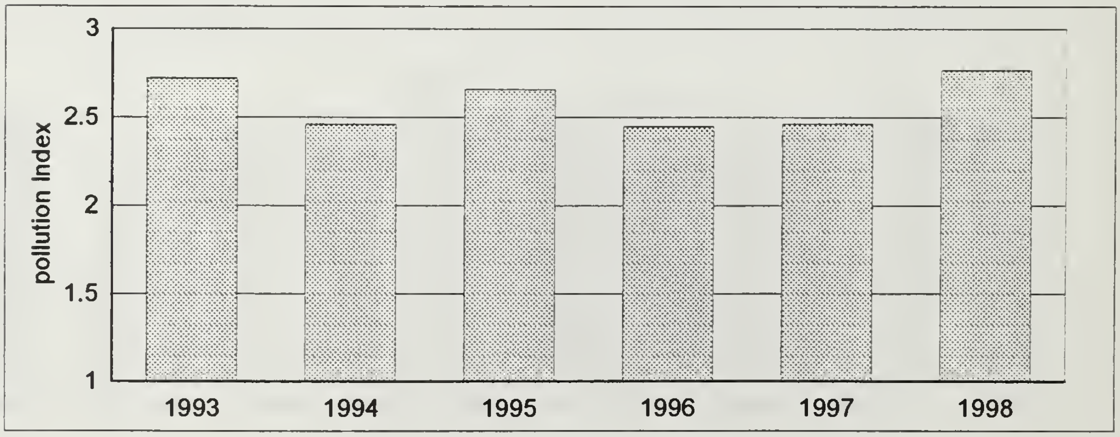


Figure 25. Pollution index values for Clark Fork at Gold Creek Bridge (station 11), 1989-1998.

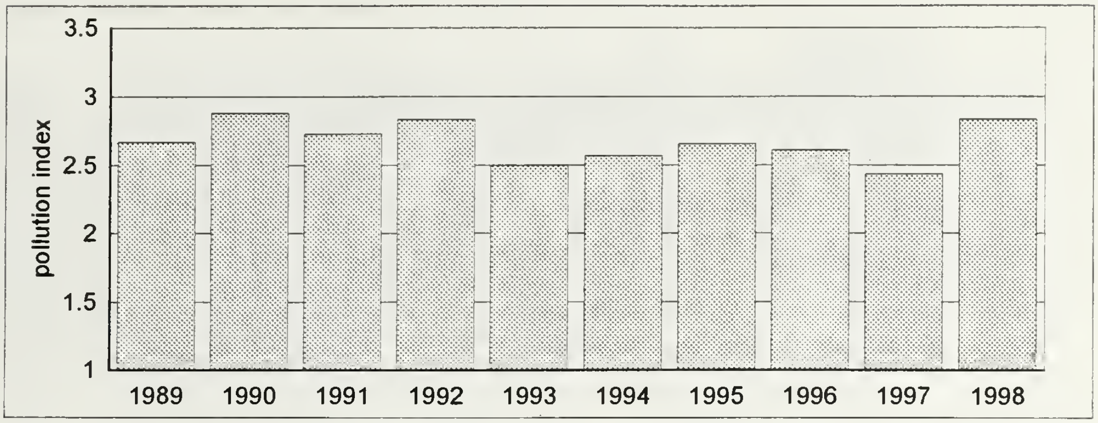


Figure 26. Pollution index values for Flint Creek at new Chicago (station 11.5), 1993-1998.

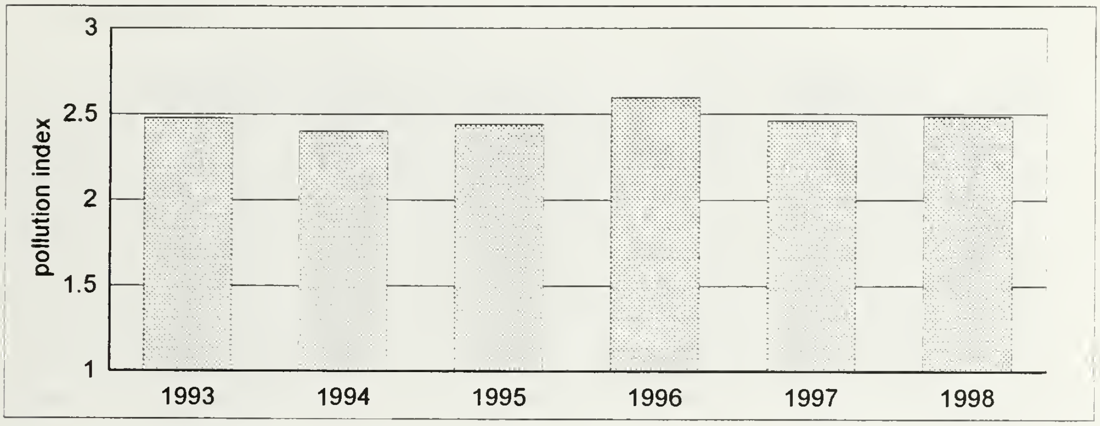


Figure 27. Pollution index values for Clark Fork at Bearmouth (station 11.7), 1993-1998.

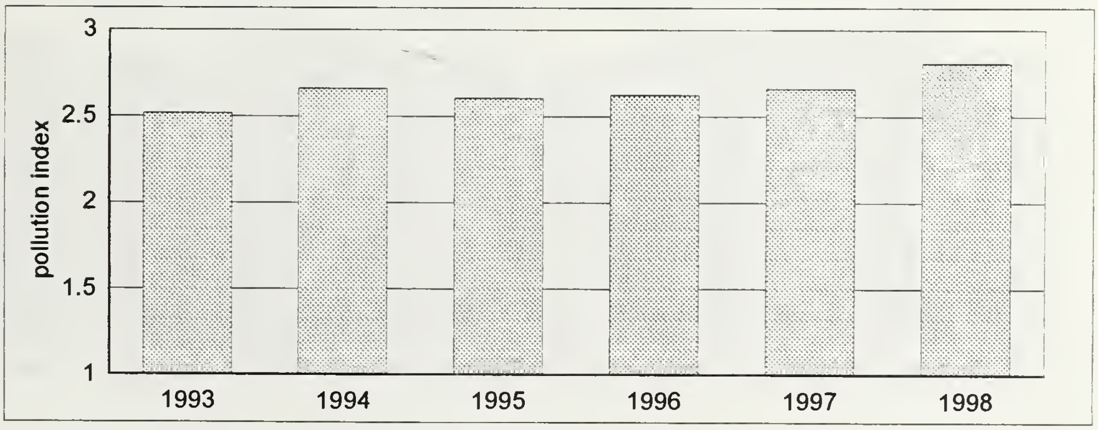


Figure 28. Pollution index values for Clark Fork at Bonita (station 12), 1989-1998.

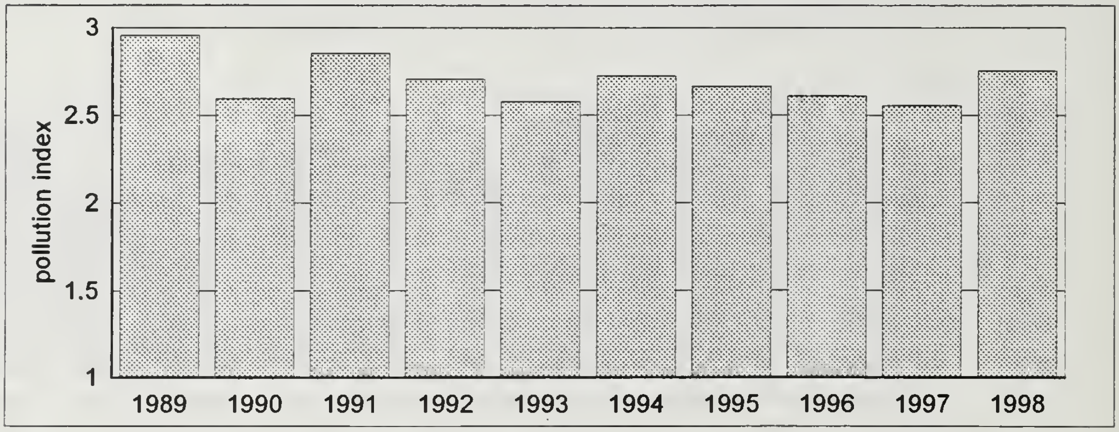


Figure 29. Pollution index values for Rock Creek near Clinton (station 12.5), 1993-1998.

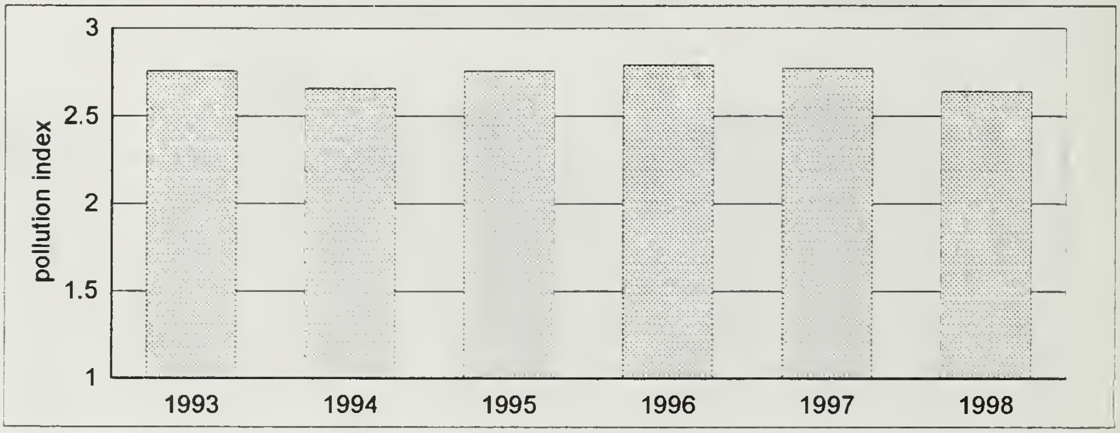


Figure 30. Pollution index values for Clark Fork at Turah (station 13), 1989-1998.

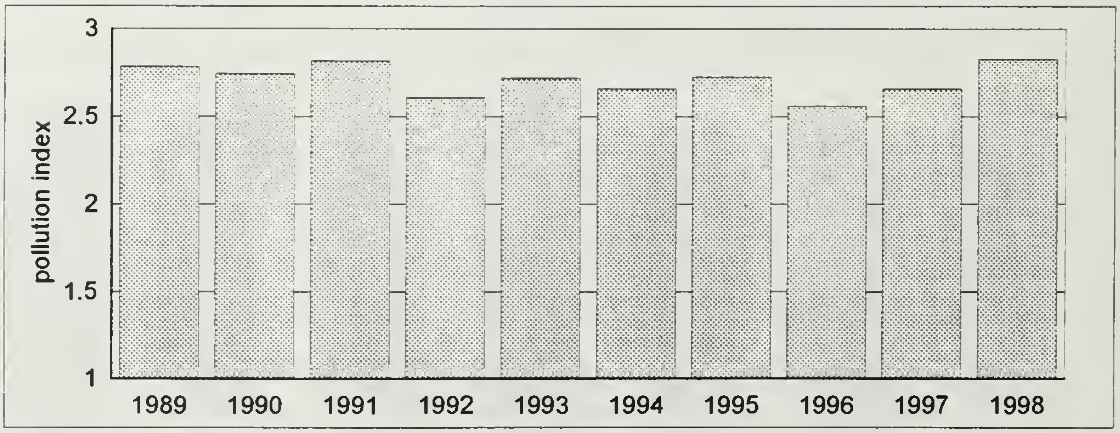


Figure 31. Pollution index values for Blackfoot River near mouth (station 14), 1989-1998.

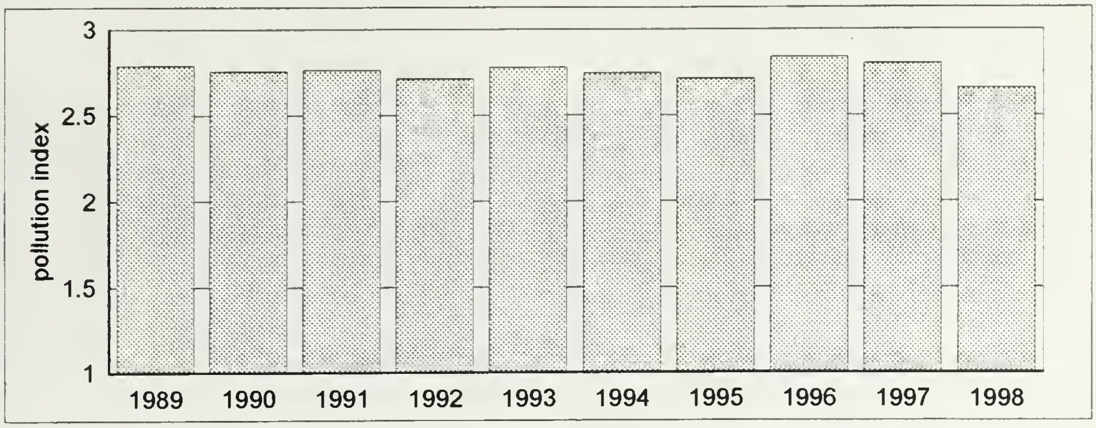


Figure 32. Pollution index values for Clark Fork above Missoula (station 15.5), 1989-1998.

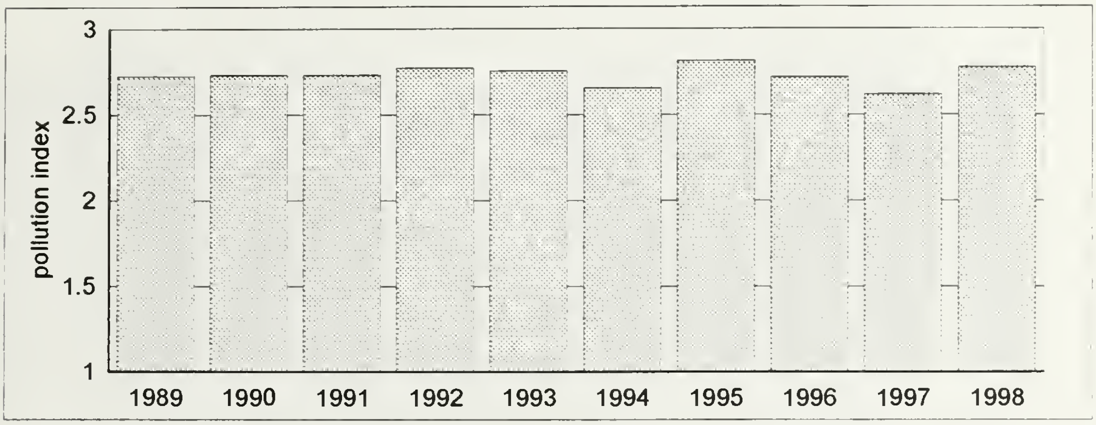


Figure 33. Pollution index values for Clark Fork at Shuffields (station 18), 1989-1998.

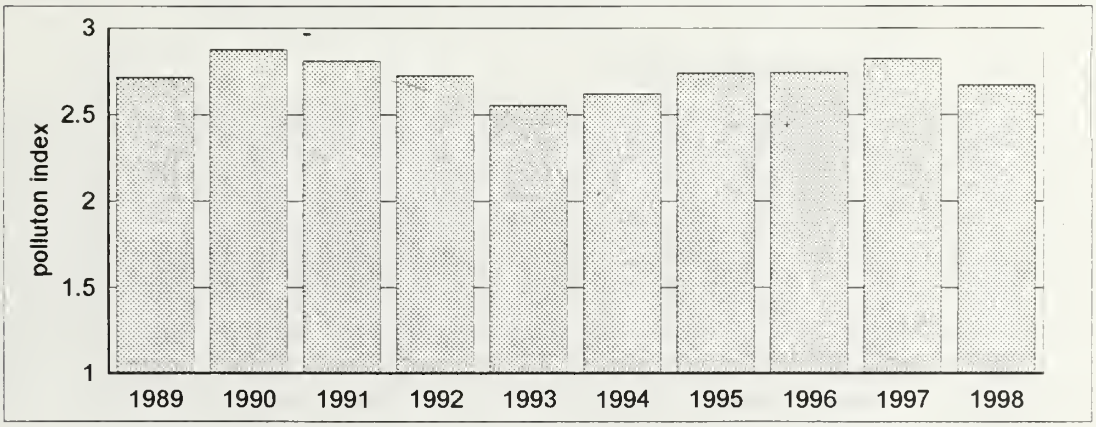


Figure 34. Pollution index values for Bitterroot River near mouth (station 19), 1989-1998.

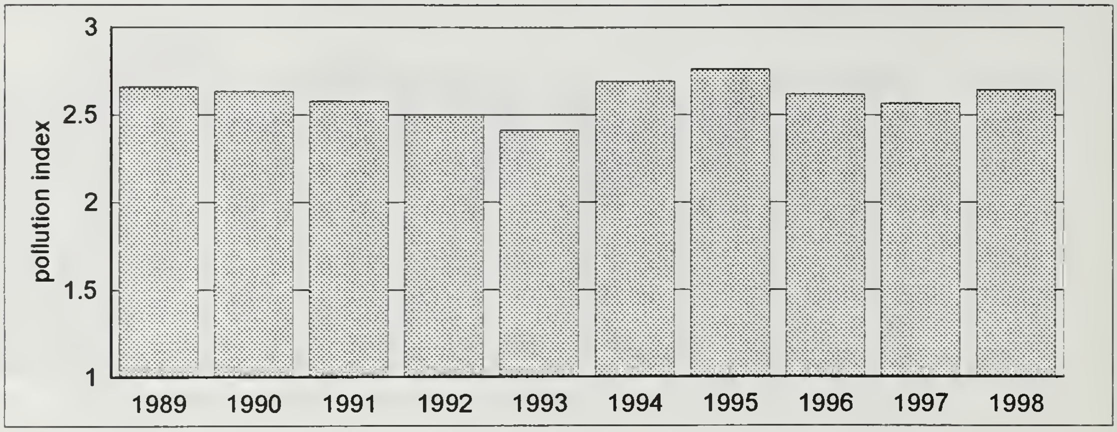


Figure 35. Pollution index values for Clark Fork at Harper Bridge (station 20), 1989-1998.

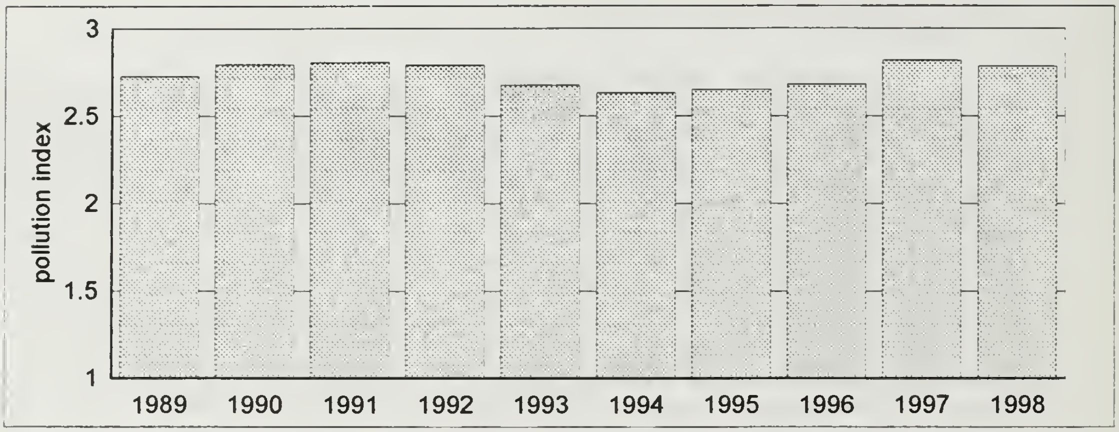


Figure 36. Pollution index values for Clark Fork at Huson (station 22), 1989-1998.

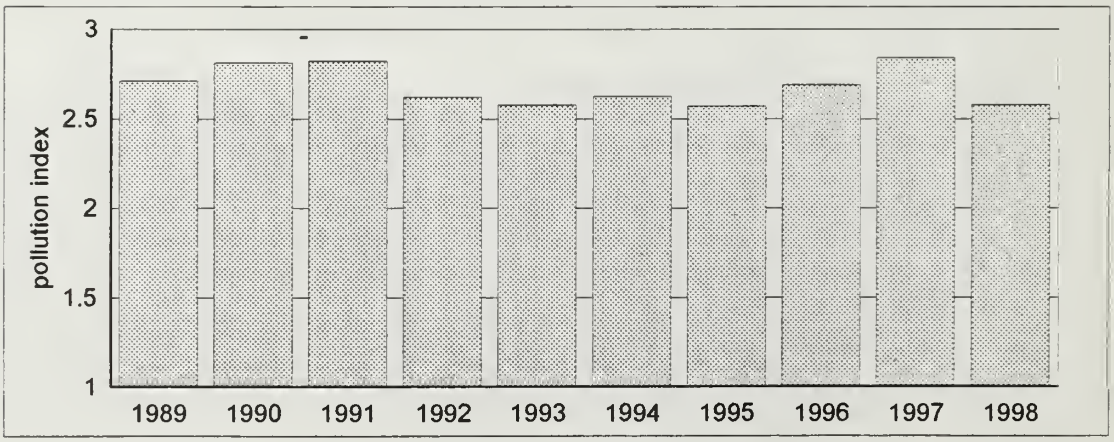


Figure 37. Pollution index values for Clark Fork near Superior (station 24), 1989-1998.

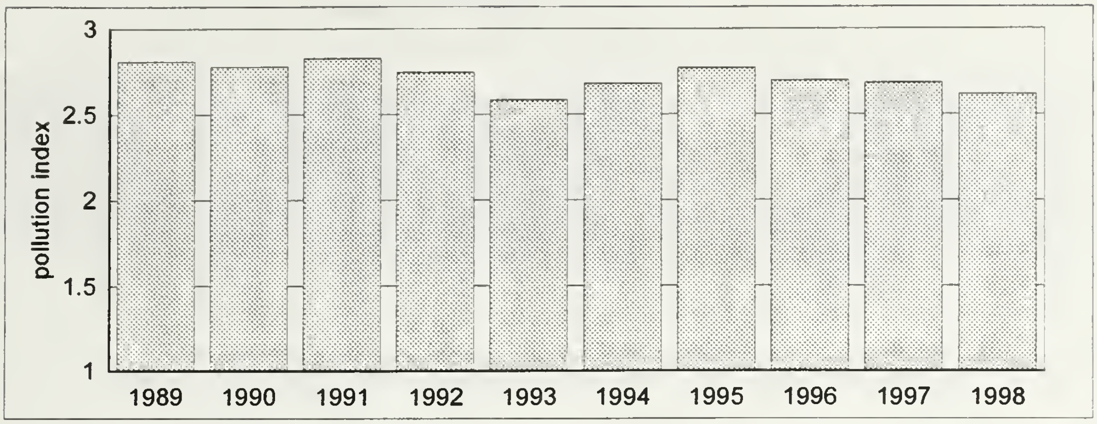


Figure 38. Pollution index values for Clark Fork above Flathead River (station 25), 1989-1998.

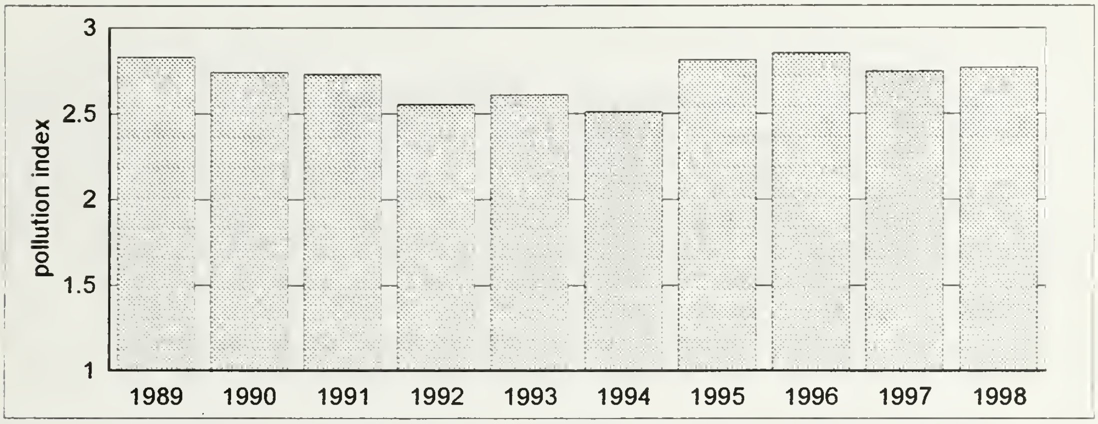


Figure 39. Pollution index values for Clark Fork above Thompson Falls Reservoir (station 27), 1989-1998.

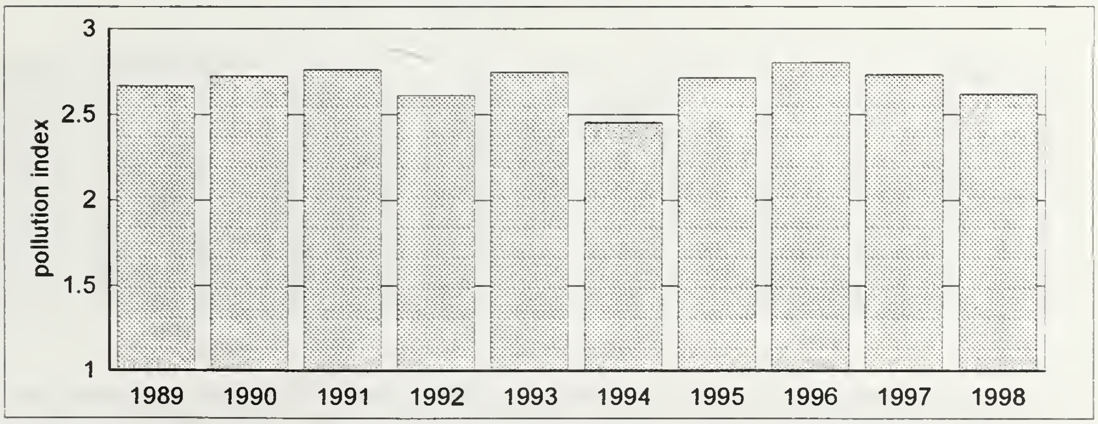


Figure 40. Pollution index values for 19 mainstem stations during August 1997, and long-term mean values for the period 1989-1997*.

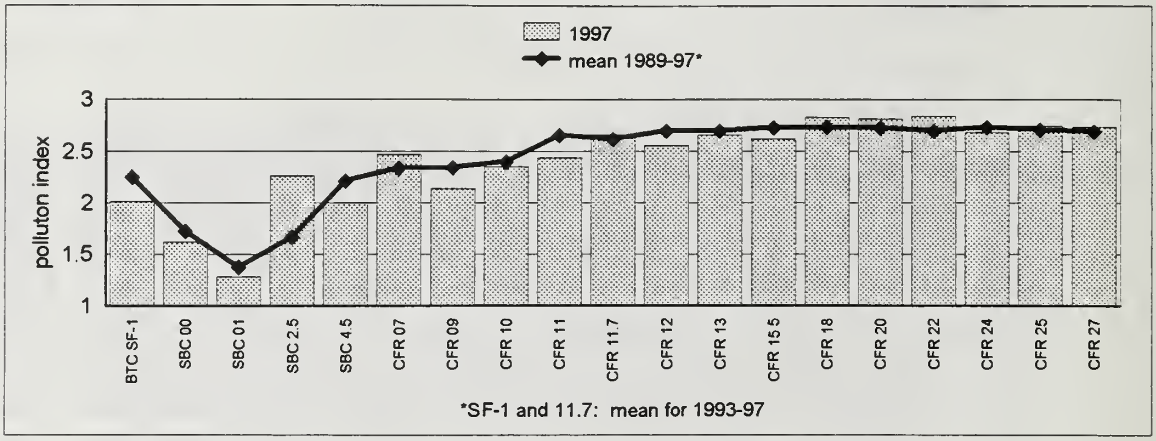


Figure 41. Pollution index values for selected Clark Fork tributaries during August 1997, and long-term mean values for the period 1989-1997*.

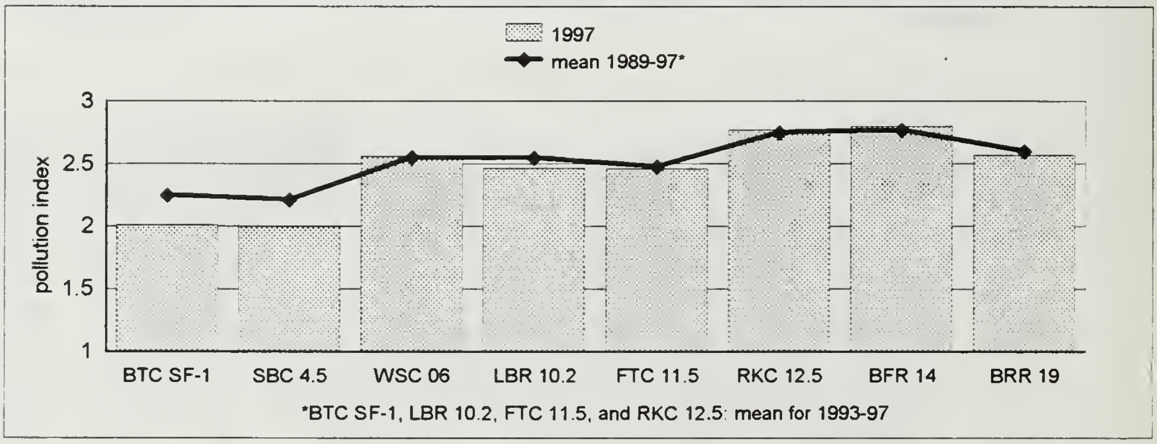
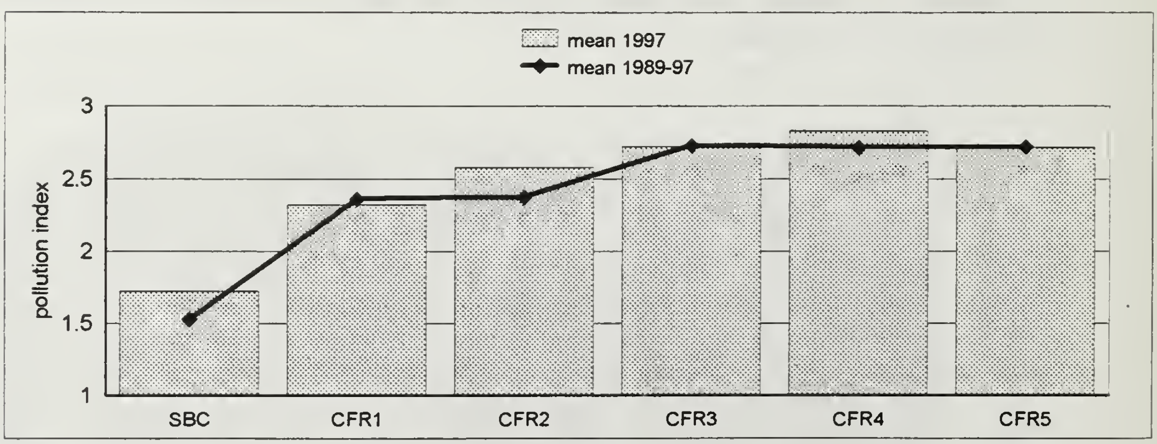


Figure 42. Mean pollution index values in Clark Fork reaches* during August 1997 and 1989-1997.



*SBC: stations 00, 01 and 2.5; CFR1: stations 07, 09 and 10; CFR2: stations 11, 11.7, 12 and 13; CFR3: stations 15.5 and 18; CFR4: stations 20 and 22; CFR5: stations 24 and 25.

Figure 43. Pollution index values for 19 mainstem stations during August 1998, and long-term mean values for the period 1989-1998*.

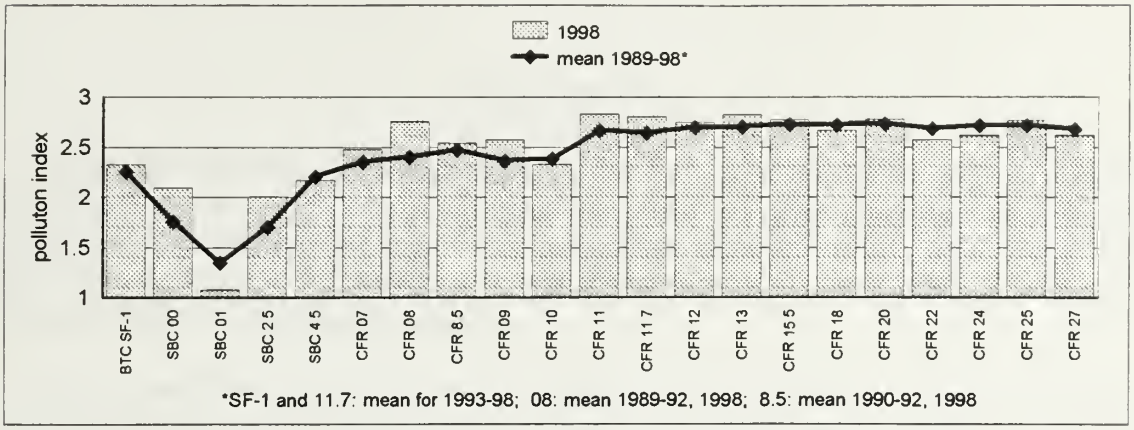


Figure 44. Pollution index values for selected Clark Fork tributaries during August 1998, and long-term mean values for the period 1989-1998*.

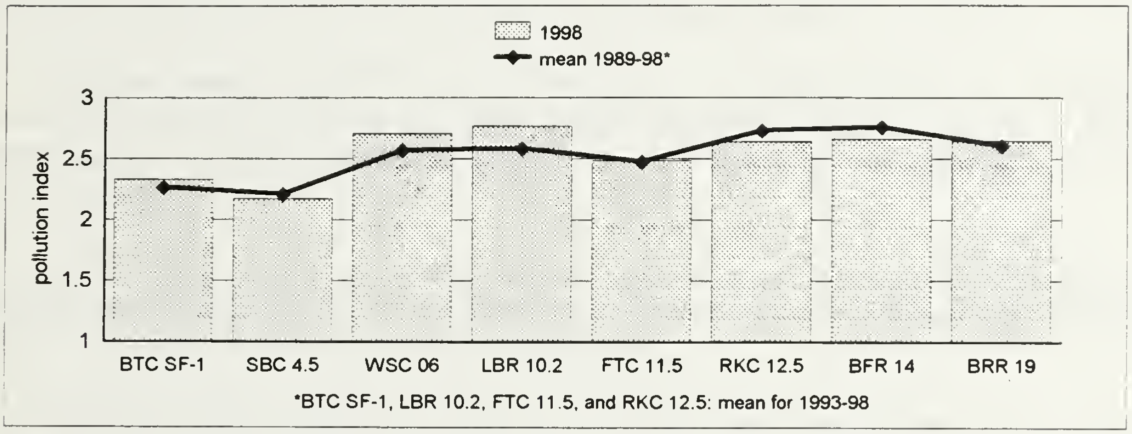
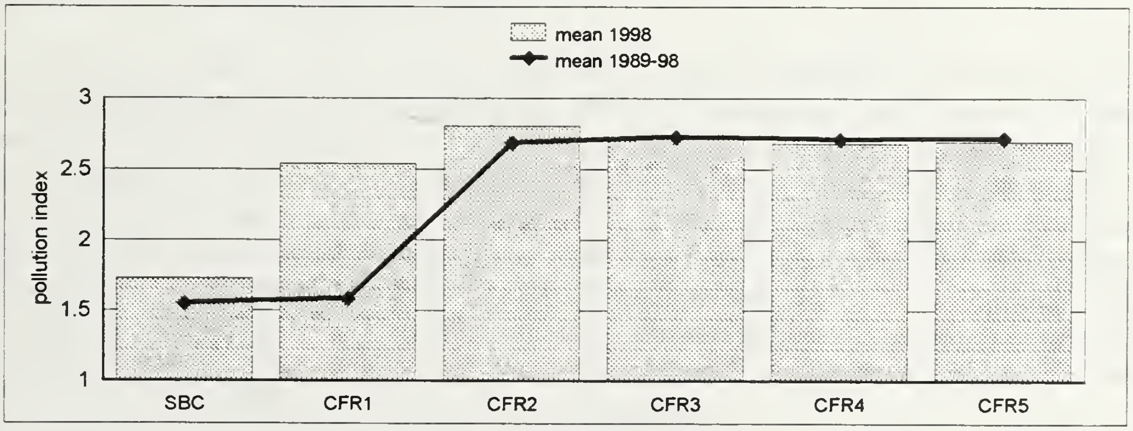


Figure 45. Mean pollution index values in Clark Fork reaches* during August 1998 and the period 1989-1998.



*SBC: stations 00, 01 and 2.5; CFR1: stations 07, 08, 8.5, 09 and 10; CFR2: stations 11, 11.7, 12 and 13; CFR3: stations 15.5 and 18; CFR4: stations 20 and 22; CFR5: stations 24 and 25.

CONCLUSIONS

1. Metrics for both non-diatom and diatom algae associations indicated continued moderate-to-severe impairment of water quality and biological integrity in the upper Clark Fork Basin in both 1997 and 1998. A general trend for improvement with distance downstream from Silver Bow Creek was apparent in the Clark Fork mainstem, although the impaired reach was considerably longer in 1997 than in 1998 due to high stream flows.

2. Silver Bow Creek stations upstream of Opportunity continued to be the most heavily impaired, with generally poor biological integrity within this reach in 1997. A mix of toxic heavy metals, sediment, and biogenic waste pollution between Butte and the Warm Springs Ponds caused excessive stress on the biota. Moderate improvement was seen upstream of the Butte WWTP outfall in 1998, as a result of ARCO's remediation efforts at the site of the Colorado Tailings. Slight improvement was also seen at the lower end of this reach in both 1997 and 1998.

3. Biological integrity in Silver Bow Creek downstream of the Warm Springs ponds in 1997 was moderately impaired, probably as a result of high inflows reducing the effectiveness of the treatment ponds. Only minor impairment of the biota was indicated in 1998, when stream flows were near average.

4. Warm Springs Creek, an important tributary to the upper Clark Fork, was rated as moderately impaired during both 1997 and 1998 due to elevated sediment, although other metrics continued to indicate the biota was relatively unimpaired.

5. Biological integrity in the upper Clark Fork between Warm Springs Creek and the Little Blackfoot River was moderately to severely impaired in 1997 due excessive sediment impacts related to generally poor streambank conditions, and high stream flows and storm run off. Conditions in this reach were generally improved in 1998, although sediment continues to be the primary cause of decreased biological integrity.

6. Biological integrity at Clark Fork stations between the Little Blackfoot River and Rock Creek displayed moderate to severe impairment in 1997 due to sediment, but improved markedly between Rock Creek and Missoula. In 1998, Clark Fork stations between the Little Blackfoot River and Missoula had good to excellent biological integrity. The Little Blackfoot River and Flint Creek were moderately impaired during 1997. Rock Creek was rated as unimpaired in 1997, but had minor impairment indicated in 1998. The Blackfoot River was unimpaired, while minor impairment related to sediment was indicated in the Bitterroot River during both 1997 and 1998. Rock Creek, the Blackfoot River and the Bitterroot River continue to be important sources of high-quality water to the Clark Fork. Minor impairment of aquatic life was indicated in the Clark Fork above Missoula in 1997, while in 1998 this site was unimpaired.

7. Biological integrity in the Clark Fork between Missoula and Superior was good to excellent in 1997, and rated as good throughout in 1998. Sediment was responsible for the minor impairment

indicated in this reach. The Missoula WWTP and possibly Stone Container Corporation likely contributed to the slight impairment of aquatic life in the lower river. Sediment impacts were generally minor in the Clark fork below Superior, and biological integrity was good to excellent above and below the Flathead River during 1997 and 1998.

8. Compared to long-term trends, impairment of the biota in Silver Bow Creek was slightly higher than average in 1997, and generally less than average in 1998. Upper Clark Fork sites displayed the greatest fluctuation in overall impairment during both years, compared to the average, but followed the same general pattern seen at Silver Bow Creek. At the remainder of tributary and mainstem Clark Fork stations, biological integrity and impairment of aquatic life was near the long-term average.

REFERENCES CITED

APHA, AWWA and WPCF. 1980. Standard methods for the examination of water and wastewater. Amer. Publ. Health Assoc., Amer. Water Works Assoc., Water Poll. Cont. Fed., Wash. D.C.

Bahls, L.L. 1979. Benthic diatom diversity as a measure of water quality. Proc. Mont. Acad. Sci. 38:1-6.

Bahls, L.L. 1987. Periphyton community structure in the Clark Fork River and its tributaries, Summer 1986. Dept. Health and Environ. Sci. Water Quality Bureau, Helena.

Bahls, L.L. 1989. An assessment of water quality in the Clark Fork River and its tributaries based on the structure and composition of summer algae associations in the stream-bottom periphyton community. Dept. Health and Environ. Sci. Water Quality Bureau, Helena.

Bahls, L.L. 1993. Periphyton bioassessment methods for Montana streams. Dept. Health and Environ. Sci., Water Quality Bureau, Helena.

Bahls, L.L. and E.E. Weber. 1988. Ecology and distribution in Montana of *Epithemia sorex* Kuntz., a common nitrogen-fixing diatom. Proc. Mont. Acad. Sci. 48:15-20.

Bahls, L., R. Bukantis and S. Tralles. 1992. Benchmark biology of Montana reference streams. Dept. Health and Environ. Sci., Water Quality Bureau, Helena.

DHES. 1989. Field procedures manual: collection, analysis and reporting of water quality samples. Dept. Health and Environ. Sci., Water Quality Bureau, Helena.

Karr, J.R. and D.R. Dudley. 1981. Ecological perspectives on water quality goals. Environmental Management 5:55-68.

Lange-Bertalot, H. 1979. Pollution tolerance of diatoms as a criterion for water quality estimation. Nova Hedwigia 64:285-304.

Plafkin, J.L., M.T. Barbour, K.D. Porter, S.K. Gross and R.M. Hughes. 1989. Rapid bioassessment protocols for use in streams and rivers: benthic macroinvertebrates and fish. EPA/444/4-89/001.

McGuire, D. L. 1996. Clark Fork River macroinvertebrate community biointegrity, 1994 assessment. Technical report prepared for the Montana Department of Environmental Quality/Water Quality Division.

Weber, C.I. ed. 1973. Biological field and laboratory methods for measuring the quality of surface waters and effluents. EPA-670/4-73-001.

Weber, E.E. 1991. An assessment of water quality in the Clark Fork River and its major tributaries, based on the structure and composition of summer algae associations in the periphyton community. PhycoLogic. East Helena, Montana.

Weber, E.E. 1993. An assessment of biological integrity and impairment of aquatic life in the Clark Fork River and its major tributaries based on the structure and composition of algae associations in the periphyton community, August 1991 and 1992. Phycologic. East Helena, Montana.

Weber, E.E. 1995. An assessment of biological integrity and impairment of aquatic life in the Clark Fork River and its major tributaries based on the structure and composition of algae associations in the periphyton community during August 1993. Phycologic. East Helena, Montana.

Weber, E.E. 1996. An assessment of biological integrity and impairment of aquatic life in the Clark Fork River and its major tributaries based on the structure and composition of algae associations in the periphyton community during August 1994. Phycologic. East Helena, Montana.

Weber, E.E. 1997. Clark Fork Basin periphyton monitoring: An assessment of biological integrity and impairment based on algal associations during August 1995. Phycologic. East Helena, Montana.

Weber, E.E. 1998. Clark Fork Basin periphyton monitoring: An assessment of biological integrity and impairment based on algal associations during August 1996. Phycologic. East Helena, Montana

TAXONOMIC REFERENCES

Krammer, K. and H. Lange-Bertalot. 1986. Bacillariophyceae.
1. Teil: Naviculaceae. In Susswasserflora von Mitteleuropa: H. Ettl, J. Gerloff, H. Heynig and D. Mollenhauer, eds. Band 2/1. Gustav Fisher Verlag, Stuttgart.

Krammer, K. and H. Lange-Bertalot. 1988. Bacillariophyceae.
2. Teil: Bacillariaceae, Epithemiaceae, Surirellaceae. In Susswasserflora von Mitteleuropa: H. Ettl, J. Gerloff, H. Heynig and D. Mollenhauer, eds. Band 2/2. Gustav Fisher Verlag, Stuttgart.

Krammer, K. and H. Lange-Bertalot. 1991a. Bacillariophyceae. 3. Teil: Centrales, Fragilariaceae, Eunotiaceae. In Susswasserflora von Mitteleuropa: H. Ettl, J. Gerloff, H. Heynig and D. Mollenhauer, eds. Band 2/3. Gustav Fisher Verlag, Stuttgart.

Krammer, K. and H. Lange-Bertalot. 1991b. Bacillariophyceae. 4. Teil: Achnanthaceae, Kritische Erganzungen zu Navicula (Lineolatae) und Gomphonema. In Susswasserflora von Mitteleuropa: H. Ettl, G. Gartner, J. Gerloff, H. Heynig and D. Mollenhauer, eds. Band 2/4. Gustav Fisher Verlag, Stuttgart.

Lange-Bertalot, H. 1993. 85 new taxa and much more than 100 taxonomic clarifications supplementary to Freshwater Flora of Middle Europe Vol. 2/1-4. J. Cramer Pub. Berlin and Stuttgart.

Patrick, R. and C.W. Reimer. 1966. The Diatoms of the United States. Volume 1: Fragilariaceae, Eunotiaceae, Achnanthaceae, Naviculaceae. Academy of Natural Sciences of Philadelphia, Monograph 13.

Patrick, R. and C.W. Reimer. 1975. The Diatoms of the United States. Volume 2, Part 1: Entomoneidaceae, Cymbellaceae, Gomphonemaceae, Epithemiaceae. Academy of Natural Sciences of Philadelphia, Monograph 13.

Prescott, G.W. 1962. Algae of the Western Great Lakes Area. With an Illustrated Key to the Genera of Desmids and Freshwater Diatoms. Otto Koeltz Science Publishers (1982).

Prescott, G.W. 1970. The Freshwater Algae. Wm. C. Brown Company Publishers, Dubuque, Iowa.

APPENDIX A

1997 Non-diatom algae genera

Estimated relative abundance and biovolume

Appendix A
Estimated relative abundance and biovolume contribution rank ( ) of diatoms and genera of non-diatom algae in periphyton samples from Clark Fork Basin biological monitoring, 1997.
R=rare; C=common; VC=very common; A=abundant; VA=very abundant

STREAM:	**BTC**	**SBC**	**SBC**	**SBC**	**SBC**
STATION NUMBER:	**SF-1**	**00**	**01**	**2.5**	**4.5**
SAMPLE NUMBER:	1398E	0847L	0102R	0245G	1399E
1997 SAMPLING DATE:	8/22	8/22	8/22	8/21	8/21
Bacillariophyta (diatoms)					
All genera collectively	A(3)	A(2)	VC(3)	VC(7)	A(4)
Chlorophyta (green algae)					
Ankistrodesmus	C(9)	C(8)			
Cladophora	VC(1)				C(5)
Closterium	R				R
Coelastrum	R				
Cosmarium	R	R		VC(6)	R
Gloeocystis		A(3)	C(4)	VA(1)	
Hormidium		VA(1)	C(7)	A(4)	
Microspora	A(4)	R			
Mougeotia		R			
Oedogonium	C(7)				A(2)
Pediastrum					VC(6)
Scenedesmus	R	C(7)	A(2)	VC(8)	R
Stigeoclonium		VC(4)	VA(1)	A(3)	A(3)
Chrysophyta (yellow-green algae)					
Tribonema	A(5)	R	C(6)		
Vaucheria	VC(2)	C(5)			
Cyanophyta (blue-green algae)					
Chamaesiphon	A(6)				
Gloeocapsa			VC(5)	VA(2)	
Oscillatoria	R	C(6)		VC(5)	
Phormidium	R				VA(1)
Rhodophyta (red algae)					
Audouinella	C(8)				

STATION NUMBER:	**SF-1**	**00**	**01**	**2.5**	**4.5**
TOTAL NON-DIATOM GENERA:	14	11	6	7	8
# DOMINANT GENERA:	8	7	6	7	5
# GREEN:	4	5	4	5	4
# BLUE-GREEN:	1	1	1	2	1
# OTHER:	3	1	1	0	0
DOMINANT PHYLUM:	Chlor	Chlor	Chlor	Chlor	Chlor

Appendix A
Estimated relative abundance and biovolume contribution rank ( ) of diatoms and genera of non-diatom algae in periphyton samples from Clark Fork Basin biological monitoring, 1997.
R=rare; C=common; VC=very common; A=abundant; VA=very abundant

STREAM:	**WSC**	**CFR**	**CFR**	**CFR**	**LBR**
STATION NUMBER:	**06**	**07**	**09**	**10**	**10.2**
SAMPLE NUMBER:	1020L	0849O	0266V	0850N	1400E
1997 SAMPLING DATE:	8/21	8/21	8/21	8/20	8/20
Bacillariophyta (diatoms)					
All genera collectively	VA(2)	VA(2)	VC(3)	A(4)	VA(1)
Chlorophyta (green algae)					
Chaetophora	R				
Cladophora	R	VC(5)	VC(1)	VC(2)	VC(4)
Closterium	R	R			C(9)
Coelastrum				R	
Cosmarium		R	R	R	VC(7)
Gloeocystis		R		R	R
Hormidium					R
Oedogonium		A(1)			
Pediastrum		C(8)	R	R	
Scenedesmus	R			C(6)	
Spirogyra	R				
Staurastrum					VC(8)
Stigeoclonium	R	A(4)		VC(5)	A(3)
Ulothrix	VC(6)				VC(5)
Chrysophyta (yellow-green algae)					
Tetrasporopsis	VA(1)				
Tribonema					R
Vaucheria	A(3)	R			
Cyanophyta (blue-green algae)					
Chamaesiphon		A(7)	VC(5)		
Nostoc		A(3)			VA(2)
Oscillatoria	A(5)	C(9)	VC(2)	A(3)	R
Phormidium	VA(4)	VA(6)	C(4)	VA(1)	A(6)
Rhodophyta (red algae)					
Audouinella	R				R
STATION NUMBER:	**06**	**07**	**09**	**10**	**10.2**
TOTAL NON-DIATOM GENERA:	12	12	6	9	13
# DOMINANT GENERA:	5	8	4	5	8
# GREEN:	1	4	1	3	6
# BLUE-GREEN:	2	4	3	2	2
# OTHER:	2	0	0	0	0
DOMINANT PHYLUM:	Chry	Chlor	Cyan	Cyan	Chlor

Appendix A
Estimated relative abundance and biovolume contribution rank ( ) of diatoms and genera of non-diatom algae in periphyton samples from Clark Fork Basin biological monitoring, 1997.
R=rare; C=common; VC=very common; A=abundant; VA=very abundant

STREAM:	CFR	FTC	CFR	CFR	RKC
STATION NUMBER:	**11**	**11.5**	**11.7**	**12**	**12.5**
SAMPLE NUMBER:	0556N	1401E	0652F	0557N	1402E
1997 SAMPLING DATE:	8/20	8/20	8/20	8/19	8/19
Bacillariophyta (diatoms)					
All genera collectively	A(2)	VA(2)	VA(2)	VA(1)	VA(1)
Chlorophyta (green algae)					
Ankistrodesmus			R	R	
Chaetophora					VC(7)
Cladophora	VC(1)	VC(3)	A(1)	VC(2)	VC(3)
Closterium		R			C(12)
Coelastrum	R				
Cosmarium	C(4)		C(6)	VC(6)	C(11)
Gloeocystis	R			R	
Gongrosira					C(13)
Pediastrum	R		R	R	
Scenedesmus	R	R	C(8)	R	R
Staurastrum		R			R
Stigeoclonium	C(5)		C(7)	A(3)	R
Ulothrix			R		VC(5)
Cyanophyta (blue-green algae)					
Calothrix			R	VC(9)	VC(9)
Chamaesiphon	C(8)	C(6)		R	
Nodularia			R	R	
Nostoc	C(7)	VA(1)	A(3)	VC(7)	C(10)
Oscillatoria	A(3)	VC(4)	VC(5)	VC(8)	A(6)
Phormidium	VC(6)	C(5)	C(9)	A(5)	VA(2)
Rivularia					R
Tolypothrix					VC(8)
Rhodophyta (red algae)					
Audouinella	R	R	VC(4)	A(4)	A(4)

STATION NUMBER:	11	11.5	11.7	12	12.5
TOTAL NON-DIATOM GENERA:	12	9	13	14	16
# DOMINANT GENERA:	7	5	8	8	12
# GREEN:	3	1	4	3	6
# BLUE-GREEN:	4	4	3	4	5
# OTHER:	0	0	1	1	1
DOMINANT PHYLUM:	Chlor	Cyan	Chlor	Chlor	Cyan

Appendix A
Estimated relative abundance and biovolume contribution rank ( ) of diatoms and genera of non-diatom algae in periphyton samples from Clark Fork Basin biological monitoring, 1997.
R=rare; C=common; VC=very common; A=abundant; VA=very abundant

STREAM:	**CFR**	**BFR**	**CFR**	**CFR**	**BRR**
STATION NUMBER:	**13**	**14**	**15.5**	**18**	**19**
SAMPLE NUMBER:	0558T	0752R	0897O	0676S	0278V
1997 SAMPLING DATE:	8/19	8/19	8/19	8/18	8/18
Bacillariophyta (diatoms)					
All genera collectively	VA(1)	VA(1)	VA(2)	VA(1)	A(2)
Chlorophyta (green algae)					
Ankistrodesmus		C(14)		R	A(4)
Chaetophora	R	A(5)	R		
Cladophora	A(2)	C(7)	A(3)	VC(2)	C(3)
Closterium		R	C(9)	C(8)	R
Coelastrum		R		R	C(9)
Cosmarium	VC(6)	VC(10)	A(6)	VC(3)	C(6)
Gloeocystis			R	R	R
Gongrosira			R	R	
Oedogonium		R			R
Pediastrum	R	R	R	R	R
Scenedesmus	R	C(13)	R	C(9)	VC(5)
Spirogyra		VC(6)			
Staurastrum		C(11)	R	R	C(7)
Stigeoclonium	A(3)		R	C(4)	R
Ulothrix	R	VC(9)	R		R
Cyanophyta (blue-green algae)					
Calothrix	C(9)	R	A(5)	R	
Chamaesiphon			C(11)		
Merismopedia	R				
Nostoc	C(7)	A(4)	VA(1)		
Oscillatoria	C(8)	VA(2)	R	C(6)	VA(1)
Phormidium	VA(5)	R	C(10)	VC(7)	VC(8)
Rivularia	R	C(12)	VC(7)		
Tolypothrix			R		
Phaeophyta (brown algae)					
Heribaudiella		VA(3)			
Rhodophyta (red algae)					
Asterocystis			C(8)		
Audouinella	A(4)	A(8)	VA(4)	C(5)	
STATION NUMBER:	**13**	**14**	**15.5**	**18**	**19**
TOTAL NON-DIATOM GENERA:	14	19	20	15	14
# DOMINANT GENERA:	8	13	10	8	8
# GREEN:	3	8	3	5	6
# BLUE-GREEN:	4	3	5	2	2
# OTHER:	1	2	2	1	0
DOMINANT PHYLUM:	Chlor	Chlor	Cyan	Chlor	Chlor

Appendix A

Estimated relative abundance and biovolume contribution rank ( ) of diatoms and genera of non-diatom algae in periphyton samples from Clark Fork Basin biological monitoring, 1997.
R=rare; C=common; VC=very common; A=abundant; VA=very abundant

STREAM:	CFR	CFR	CFR	CFR	CFR
STATION NUMBER:	**20**	**22**	**24**	**25**	**27**
SAMPLE NUMBER:	0272W	273AB	0901N	0903N	0905R
1997 SAMPLING DATE:	8/18	8/18	8/18	8/17	8/17
Bacillariophyta (diatoms)					
All genera collectively	VA(1)	VA(1)	A(3)	VA(1)	VA(1)
Chlorophyta (green algae)					
Ankistrodesmus	C(10)	C(9)	C(6)	VC(7)	C(8)
Chaetophora				R	R
Chroococcus					R
Cladophora	VC(2)	VC(3)	VC(2)	C(3)	
Closterium	R	R	R	R	C(4)
Coelastrum		R	R	C(9)	R
Cosmarium	VC(5)	C(6)	C(4)	VC(4)	VC(3)
Dimorphococcus					R
Gloeocystis		C(7)		R	R
Mougeotia					R
Oedogonium			R		
Pediastrum	R	R	R		R
Scenedesmus	C(9)	C(8)	C(5)	VC(5)	C(7)
Sphaerocystis					R
Staurastrum	R	R	R		C(5)
Stigeoclonium	C(7)	VA(2)	R	VA(2)	
Ulothrix	C(6)	R		R	
Cyanophyta (blue-green algae)					
Calothrix			R	R	R
Chamaesiphon			R		
Oscillatoria	A(3)	A(4)	VA(1)		VA(2)
Phormidium	A(4)	A(5)		A(6)	VC(6)
Rivularia				C(8)	
Tolypothrix	R			R	
Rhodophyta (red algae)					
Audouinella	C(8)		R	R	

STATION NUMBER:	**20**	**22**	**24**	**25**	**27**
TOTAL NON-DIATOM GENERA:	13	13	14	15	16
# DOMINANT GENERA:	9	8	5	8	7
# GREEN:	6	6	4	6	5
# BLUE-GREEN:	2	2	1	2	2
# OTHER:	1	0	0	0	0
DOMINANT PHYLUM:	Chlor	Chlor	Chlor	Chlor	Chlor

APPENDIX B

1998 Non-diatom algae genera
Estimated relative abundance and biovolume

Appendix B
Estimated relative abundance and biovolume contribution rank ( ) of diatoms and genera of non-diatom algae in periphyton samples from Clark Fork Basin biological monitoring, 1998.
R=rare; C=common; VC=very common; A=abundant; VA=very abundant

STREAM:	BTC	SBC	SBC	SBC	SBC
STATION NUMBER:	**SF-1**	**00**	**01**	**2.5**	**4.5**
SAMPLE NUMBER:	1398F	0847M	0102S	0245H	1399F
1998 SAMPLING DATE:	8/16	8/16	8/16	8/15	8/15
Bacillariophyta (diatoms)					
All genera collectively	VA(2)	VC(2)	VA(3)	C(7)	VA(3)
Chlorophyta (green algae)					
Ankistrodesmus	A(7)	R			
Cladophora	VC(4)				VC(4)
Closterium	R				R
Cosmarium				C(5)	
Gloeocystis		R	VC(5)	A(2)	
Hormidium		R			
Microspora	VA(1)				
Oedogonium	A(3)				A(1)
Pediastrum					C(7)
Scenedesmus	R	C(3)	A(4)	VC(4)	
Sphaerocystis					R
Stigeoclonium		R	VA(1)	VA(1)	VA(2)
Chrysophyta (yellow-green algae)					
Tribonema	VC(6)				
Vaucheria	VC(5)	VA(1)	A(2)		
Cyanophyta (blue-green algae)					
Aphanocapsa					VA(5)
Chamaesiphon					R
Gloeocapsa				A(3)	
Oscillatoria	C(8)	R		C(6)	
Phormidium					A(6)

STATION NUMBER:	**SF-1**	**00**	**01**	**2.5**	**4.5**
TOTAL NON-DIATOM GENERA:	9	7	4	6	9
# DOMINANT GENERA:	7	2	4	6	6
# GREEN:	4	1	3	4	4
# BLUE-GREEN:	1	0	0	1	2
# OTHER:	2	1	1	0	0
DOMINANT PHYLUM:	Chlor	Chry	Chlor	Chlor	Chlor

Appendix B
Estimated relative abundance and biovolume contribution rank ( ) of diatoms and genera of non-diatom algae in periphyton samples from Clark Fork Basin biological monitoring, 1998.
R=rare; C=common; VC=very common; A=abundant; VA=very abundant

STREAM:	WSC	CFR	CFR	CFR	CFR	CFR
STATION NUMBER:	06	07	08	8.5	09	10
SAMPLE NUMBER:	1020L	0849O	1021H	1049D	0266W	0850O
1998 SAMPLING DATE:	8/15	8/15	8/15	8/15	8/15	8/14
Bacillariophyta (diatoms)						
All genera collectively	VA(2)	VA(2)	VC(2)	A(2)	VA(2)	VA(2)
Chlorophyta (green algae)						
Ankistrodesmus		R				
Cladophora		C(6)	C(5)	C(6)	A(1)	A(1)
Closterium	C(6)	R				R
Coelastrum						R
Cosmarium					R	R
Gloeocystis				R		
Oedogonium		VA(1)	VA(1)	VC(4)	VC(5)	
Pediastrum		C(7)	R	C(7)	R	C(5)
Scenedesmus				R		R
Spirogyra				R		
Stigeoclonium	R			VA(1)	VA(3)	A(4)
Chrysophyta (yellow-green algae)						
Vaucheria	A(4)					
Cyanophyta (blue-green algae)						
Anabaena						R
Aphanocapsa		A(3)	VC(4)	R		
Calothrix						C(6)
Chamaesiphon		A(5)	A(3)	A(5)	C(6)	VC(7)
Nostoc	C(5)					
Oscillatoria	VA(1)	C(8)	R	R	R	R
Phormidium	VA(3)	VA(4)	C(6)	VA(3)	VA(4)	VA(3)
Rhodophyta (red algae)						
Audouinella	R					

STATION NUMBER:	06	07	08	8.5	09	10
TOTAL NON-DIATOM GENERA:	7	9	7	11	8	12
# DOMINANT GENERA:	5	7	5	6	5	6
# GREEN:	1	3	2	4	3	3
# BLUE-GREEN:	3	4	3	2	2	3
# OTHER:	1	0	0	0	0	0
DOMINANT PHYLUM:	Cyan	Cyan	Chlor/Cyan	Chlor	Chlor	Chlor

Appendix B
Estimated relative abundance and biovolume contribution rank ( ) of diatoms and genera of non-diatom algae in periphyton samples from Clark Fork Basin biological monitoring, 1998.
R=rare; C=common; VC=very common; A=abundant; VA=very abundant

STREAM:	LBR	CFR	FTC	CFR	CFR	RKC
STATION NUMBER:	**10.2**	**11**	**11.5**	**11.7**	**12**	**12.5**
SAMPLE NUMBER:	1400F	0556O	1401F	0652G	0557O	1402F
1998 SAMPLING DATE:	8/14	8/14	8/14	8/14	8/14	8/14
Bacillariophyta (diatoms)						
All genera collectively	VA(1)	VA(1)	VA(1)	VA(1)	VA(1)	VA(1)
Chlorophyta (green algae)						
Ankistrodesmus	VC(13)	R		C(10)	C(9)	VC(9)
Chaetophora						R
Cladophora	C(6)	VC(3)	VC(2)	A(2)	VC(3)	VC(2)
Closterium	C(9)		VC(5)	R	VC(7)	R
Coelastrum		R			R	
Cosmarium	VC(4)	R		VC(6)	VC(6)	R
Gloeocystis		R	R		R	
Mougeotia	C(8)					R
Pediastrum	R	C(8)		R	R	
Scenedesmus	R	R	C(10)	R	R	R
Spirogyra	C(10)					
Staurastrum	C(14)		VC(6)	R	R	
Stigeoclonium	R	C(9)	R	A(4)	A(5)	
Ulothrix	R					R
Zygnema						R
Chrysophyta (yellow-green algae)						
Tribonema						R
Cyanophyta (blue-green algae)						
Anabaena	C(11)	A(5)		R		R
Calothrix	VC(7)	VC(6)		VC(7)	R	A(4)
Chamaesiphon		C(10)	A(7)	VC(9)	VC(8)	
Nostoc	A(2)	A(4)	A(4)	VC(5)	VA(2)	R
Oscillatoria	A(3)	R	A(3)	R		C(8)
Phormidium	VC(12)	A(7)	VC(8)	VC(8)	R	A(5)
Phaeophyta (brown algae)						
Heribaudiella						C(7)
Rhodophyta (red algae)						
Audouinella	VC(5)	A(2)	C(9)	VA(3)	VA(4)	C(6)
Lemanea						VC(3)

STATION NUMBER:	**10.2**	**11**	**11.5**	**11.7**	**12**	**12.5**
TOTAL NON-DIATOM GENERA:	17	15	11	15	15	18
# DOMINANT GENERA:	13	9	9	9	8	8
# GREEN:	7	3	4	4	5	2
# BLUE-GREEN:	5	5	4	4	2	3
# OTHER:	1	1	1	1	1	3
DOMINANT PHYLUM:	Chlor/Cyan	Cyan	Cyan	Chlor	Chlor	Cyan

Appendix B
Estimated relative abundance and biovolume contribution rank ( ) of diatoms and genera of non-diatom algae in periphyton samples from Clark Fork Basin biological monitoring, 1998.
R=rare; C=common; VC=very common; A=abundant; VA=very abundant

STREAM:	**CFR**	**BFR**	**CFR**	**CFR**	**BRR**
STATION NUMBER:	**13**	**14**	**15.5**	**18**	**19**
SAMPLE NUMBER:	0558U	0752S	0897P	0676T	0278W
1998 SAMPLING DATE:	8/13	8/13	8/13	8/13	8/13
Bacillariophyta (diatoms)					
All genera collectively	VA(3)	VA(1)	VA(3)	VA(1)	VA(1)
Chlorophyta (green algae)					
Ankistrodesmus	C(8)	VC(16)	C(12)	VC(8)	VC(7)
Chaetophora		C(13)	R		
Cladophora	VA(1)	C(9)	A(1)	A(2)	VC(3)
Closterium	R	R	R	C(10)	R
Coelastrum	R	R	R	R	R
Cosmarium	C(7)	VC(6)	C(8)	VC(7)	C(10)
Gloeocystis		R		R	R
Gongrosira		C(14)	C(10)	R	
Hormidium					R
Mougeotia		C(11)	R		C(8)
Oedogonium		R			
Pediastrum	R	R	R	R	C(9)
Scenedesmus	R	C(17)	C(11)	R	VC(6)
Spirogyra		VC(4)			VC(5)
Staurastrum		R		R	VC(4)
Stigeoclonium	C(6)	A(2)	R	A(4)	R
Ulothrix		VC(3)			R
Cyanophyta (blue-green algae)					
Anabaena			R		R
Aphanocapsa					R
Calothrix	A(4)	A(5)	VC(7)	C(11)	
Chamaesiphon				A(9)	
Nostoc	VC(5)	C(15)	VA(2)		
Oscillatoria		VC(7)		VA(3)	VA(2)
Phormidium	C(9)	A(8)	A(6)	VA(6)	R
Rivularia		R			
Phaeophyta (brown algae)					
Heribaudiella			C(9)		
Rhodophyta (red algae)					
Asterocystis		R	VC(5)		
Audouinella	VA(3)	C(12)	A(4)	A(5)	R
Lemanea		C(10)			
STATION NUMBER:	**13**	**14**	**15.5**	**18**	**19**
TOTAL NON-DIATOM GENERA:	12	24	18	16	19
# DOMINANT GENERA:	8	16	11	10	9
# GREEN:	4	10	5	5	8
# BLUE-GREEN:	3	4	3	4	1
# OTHER:	1	2	3	1	0
DOMINANT PHYLUM:	Chlor	Chlor	Chlor/Cyan	Chlor	Chlor

Appendix B
Estimated relative abundance and biovolume contribution rank ( ) of diatoms and genera of non-diatom algae in periphyton samples from Clark Fork Basin biological monitoring, 1998.
R=rare; C=common; VC=very common; A=abundant; VA=very abundant

STREAM:	**CFR**	**CFR**	**CFR**	**CFR**	**CFR**
STATION NUMBER:	**20**	**22**	**24**	**25**	**27**
SAMPLE NUMBER:	0272X	273AC	0901O	0903O	0905S
1998 SAMPLING DATE:	8/13	8/12	8/12	8/12	8/12
Bacillariophyta (diatoms)					
All genera collectively	VA(1)	VA(1)	VA(4)	VA(1)	VA(1)
Chlorophyta (green algae)					
Ankistrodesmus	VC(10)	A(7)	VC(7)	VC(12)	C(15)
Chaetophora				R	
Cladophora	VC(3)	VC(2)	A(3)	A(2)	C(5)
Closterium	C(7)	C(8)	C(6)	C(10)	C(13)
Coelastrum	R	R	R		R
Cosmarium	VC(6)	VC(5)	VC(5)	VC(5)	VC(7)
Gloeocystis		R			
Hormidium	R			R	R
Mougeotia	R			R	C(11)
Oedogonium					C(10)
Pediastrum	C(9)	C(11)	C(10)	R	R
Scenedesmus	C(11)	VC(9)	C(8)	VC(7)	C(12)
Sphaerocystis		R		R	
Spirogyra				R	VC(2)
Staurastrum	VC(5)	VC(4)	R	R	R
Stigeoclonium	C(8)	A(3)	VA(1)	C(8)	VC(3)
Ulothrix	R				R
Cyanophyta (blue-green algae)					
Anabaena			R	R	
Calothrix	R	R		C(11)	C(14)
Chamaesiphon	R				
Dichothrix					VC(8)
Merismopedia					R
Oscillatoria	A(2)	VC(6)	VA(2)	R	A(4)
Phormidium	A(4)	VC(10)	C(9)	VA(4)	A(9)
Rivularia				VC(6)	
Tolypothrix			R	C(9)	VC(6)
Rhodophyta (red algae)					
Asterocystis				C(13)	R
Audouinella		R	R	A(3)	

STATION NUMBER:	**20**	**22**	**24**	**25**	**27**
TOTAL NON-DIATOM GENERA:	16	15	14	21	21
# DOMINANT GENERA:	10	10	9	12	14
# GREEN:	8	8	7	6	9
# BLUE-GREEN:	2	2	2	4	5
# OTHER:	0	0	0	2	0
DOMINANT PHYLUM:	Chlor	Chlor	Chlor	Chlor	Chlor

APPENDIX C

1997 Diatom data

Taxa, proportional count and metrics

Appendix C

Diatom proportional count data, Clark Fork Basin biological monitoring, August 17-21, 1997.
PT = Pollution Tolerance group number; PRA = Percent Relative Abundance. A letter "p" denotes species seen during floristic scan, but not during count.

STREAM:		**BTC**	**SBC**	**SBC**	**SBC**	**SBC**
STATION NUMBER:		**SF-1**	**00**	**01**	**2.5**	**4.5**
SAMPLE NUMBER:		1398E	0847L	0102R	0245G	1399E
1997 SAMPLING DATE:		8/22	8/22	8/22	8/21	8/21
SPECIES	PT	PRA	PRA	PRA	PRA	PRA
Achnanthes biasolettiana	3				p	
Achnanthes exigua	3	p			p	
Achnanthes hungarica	2		p			
Achnanthes lanceolata	2	11.92	3.57	p	0.71	3.68
Achnanthes marginulata	3	p				p
Achnanthes minutissima	3	0.73	13.81	14.05	62.62	3.43
Amphora libyca	3	0.24	p			
Amphora pediculus	3	p	p		p	p
Amphora veneta	1					4.66
Aulacoseira crenulata	3		p			p
Aulacoseira granulata	3		p			p
Caloneis bacillum	2	p	1.90	p	p	
Caloneis molaris	3		p			
Cocconeis pediculus	3	0.97				0.25
Cocconeis placentula	3	1.95	p		0.24	3.68
Cyclostephanos invisitatus	2		p	p		
Cyclotella meneghiniana	2	3.03	0.95	0.24	p	0.25
Cymatopleura solea	2		p			
Cymbella affinis	3					p
Cymbella descripta	3					p
Cymbella minuta	2	p	0.24			
Cymbella reichardtii	3	0.24	p	p		
Cymbella silesiaca	3	7.54	4.52	p		0.49
Cymbella sinuata	3	0.24			p	1.96
Diatoma vulgaris	3	p	0.24			0.49
Fragilaria brevistriata	3					0.49
Fragilaria capucina	2	3.89	3.81	p	p	6.37
Fragilaria construens	3	9.25	4.76	p	0.24	1.23
Fragilaria cyclopum	2					p
Fragilaria leptostauron	3				p	0.49
Fragilaria nitzschioides	3		p			p
Fragilaria parasitica	2	p				p
Fragilaria pinnata	3	p			p	0.49
Fragilaria ulna	2	p			p	2.94
Frustulia vulgaris	2	p				
Gomphonema acuminatum	3				p	
Gomphonema aquaemineralis	3	0.97				2.21
Gomphonema clavatum	2				p	p
Gomphonema gracile	2		p		p	
Gomphonema micropus	2					0.25
Gomphonema minutum	3	3.16	0.71		p	
Gomphonema olivaceum	3				p	p
Gomphonema parvulum	1	6.81	3.33	p	0.24	2.70
Gomphonema pumilum	3	0.24			p	
Gomphonema truncatum	3	p				
Gomphonema utae	2					p
Melosira varians	2	4.14	p			4.17
Meridion circulare	3	0.24	p		p	0.25
Navicula accomoda	1				p	

Appendix C (continued)

STREAM:		BTC	SBC	SBC	SBC	SBC
STATION NUMBER:		SF-1	00	01	2.5	4.5
SPECIES	PT	PRA	PRA	PRA	PRA	PRA
Navicula aquaedurae	2	0.49	p			
Navicula atomus	1	0.49	7.38	63.10	11.19	2.70
Navicula capitata	2	0.49	0.24			p
Navicula capitatoradiata	2	1.22	p		p	
Navicula clementioides	3	p				
Navicula clementis	2					p
Navicula contenta	2	p				
Navicula cryptocephala	3	0.49	p			p
Navicula cryptotenella	2	0.24				0.49
Navicula decussis	3	0.73	0.48	p		0.49
Navicula elginensis	3	p				
Navicula gallica	2	0.24				
Navicula gregaria	2	0.49	0.24	p	p	0.49
Navicula ignota	2	0.24	p	p		p
Navicula laevissima	3		p			
Navicula lanceolata	2	0.24	0.24		p	0.49
Navicula libonensis	2	p	p		p	
Navicula lundii	2					p
Navicula mediocris	2		p			
Navicula menisculus	2	p				0.49
Navicula minima	1	5.35	22.86	19.05	20.00	0.49
Navicula minuscula	1	1.70	0.24			1.23
Navicula molestiformis	1	p				
Navicula mutica	2				p	
Navicula nivialis	2				p	
Navicula notha	2	p				
Navicula oligotraphenta	3	0.73	0.24			
Navicula protracta	2	0.24	p			p
Navicula pupula	2	0.24	0.71	p		
Navicula reichardtiana	2	p				3.19
Navicula subminuscula	1	0.97				
Navicula tenelloides	1	p				
Navicula tnpunctata	3	0.24			p	p
Navicula trivialis	2	p				p
Navicula veneta	1	p			p	p
Navicula viridula	2				p	
Navicula wiesnen	1	1.46	p	p		p
Nitzschia acicularis	2	1.95	0.48			1.23
Nitzschia amphibia	2	0.73	p			0.25
Nitzschia archibaldii	2			p		3.92
Nitzschia capitellata	2				p	
Nitzschia denticula	3	p				0.25
Nitzschia dissipata	3	13.63	p			2.21
Nitzschia fonticola	3	0.73	0.71		p	2.45
Nitzschia hantzschiana	3	0.24	p	p		0.74
Nitzschia heufleriana	3	p				
Nitzschia inconspicua	2	1.95	0.24	0.24	p	3.19
Nitzschia linearis	2	p	1.19		p	3.19
Nitzschia palea	1	0.24	6.67	0.24	0.24	6.13
Nitzschia paleacea	2	0.97	0.71			17.65
Nitzschia perminuta	3	p	p			
Nitzschia pura	2					p
Nitzschia pusilla	1	0.49	0.48	0.71		p
Nitzschia radicula	2					p
Nitzschia recta	3	p				p

Appendix C (continued)

STREAM:		BTC	SBC	SBC	SBC	SBC
STATION NUMBER:		SF-1	00	01	2.5	4.5
SPECIES	PT	PRA	PRA	PRA	PRA	PRA
Nitzschia sociabilis	1	p	p		p	
Nitzschia supralitorea	2				p	0.74
Nitzschia tubicola	1	0.24				
Nitzschia umbonata	1					p
Pinnularia microstauron	2					p
Rhoicosphenia abbreviata	3	0.24	0.24	p	p	4.17
Stauroneis smithii	2					p
Stephanodiscus medius	2	p				
Surirella angusta	1	p	15.71	2.38	3.57	0.25
Surirella brebissonii	2		0.48			0.49
Surirella minuta	2	0.24	2.62	p	0.95	2.70
Thalassiosira pseudonana	2	1.46	p	p		

Frustules Counted:	411	420	420	420	408
Total Species:	79	60	26	44	74
Species Counted:	49	31	8	10	45
Shannon Diversity:	4.46	3.69	1.51	1.61	4.70
Pollution Index:	2.01	1.62	1.29	2.26	2.00
Siltation Index:	37.71	61.90	85.71	35.95	55.39
Disturbance Index	0.73	13.81	14.05	62.62	3.43
Total PRA PT Group 1:	17.76	56.67	85.48	35.24	18.14
Total PRA PT Group 2:	39.42	17.62	0.48	1.67	56.13
Total PRA PT Group 3:	42.82	25.71	14.05	63.10	25.74

Appendix C
Diatom proportional count data, Clark Fork Basin biological monitoring, August 17-21, 1997.
PT = Pollution Tolerance group number; PRA = Percent Relative Abundance. A letter "p" denotes species seen during floristic scan, but not during count.

STREAM:		**WSC**	**CFR**	**CFR**	**CFR**	**LBR**
STATION NUMBER:		**06**	**07**	**09**	**10**	**10.2**
SAMPLE NUMBER:		1020L	0849O	0266V	0850N	1400E
1997 SAMPLING DATE:		8/21	8/21	8/21	8/20	8/20
SPECIES	PT	PRA	PRA	PRA	PRA	PRA
Achnanthes biasolettiana	3	0.24	0.24		0.24	
Achnanthes lanceolata	2	p	1.22	p	0.47	1.20
Achnanthes lauenbergiana	2					
Achnanthes marginulata	3					p
Achnanthes minutissima	3	26.41	9.25	4.71	0.94	1.92
Amphipleura pellucida	2		p			p
Amphora inariensis	3					p
Amphora libyca	3	p				
Amphora montana	2	p		p		
Amphora pediculus	3	0.24	0.24	0.24	p	0.96
Amphora veneta	1		3.89	0.24	0.24	
Aulacoseira distans	3		p			
Caloneis bacillum	2			p		
Caloneis silicua	2					p
Cocconeis pediculus	3		1.70			p
Cocconeis placentula	3	0.49	3.65	0.94	1.18	2.64
Cyclotella distinguenda	2	p				
Cyclotella meneghiniana	2	0.24	p	p	p	0.48
Cyclotella pseudostelligera	2					0.24
Cymbella affinis	3	1.96	p			5.53
Cymbella lapponica	3	p				
Cymbella mesiana	3	0.49	p			
Cymbella minuta	2	2.20	0.24		p	
Cymbella reichardtii	3	p	0.24	3.06		
Cymbella silesiaca	3	5.87	2.43	5.18	7.55	5.77
Cymbella sinuata	3	1.71	1.95	2.35	0.71	0.48
Cymbella turgidula	3	2.69	0.24	p		5.77
Diatoma hyemalis	3	p	p			
Diatoma mesodon	3	p	p		p	
Diatoma tenuis	2	p				
Diatoma vulgaris	3	0.24	2.43		p	8.65
Epithemia adnata	2	p	p			
Epithemia sorex	3		0.49			0.96
Fragilaria brevistriata	3	p	0.49		p	p
Fragilaria capucina	2	2.44	6.33	5.65	4.95	4.57
Fragilaria construens	3	0.73	3.65	0.94	0.24	2.16
Fragilaria leptostauron	3	1.47	0.49	p	0.24	
Fragilaria mazamaensis	3	p	p			p
Fragilaria nanana	3	p				
Fragilaria parasitica	2		p			
Fragilaria pinnata	3	1.22	0.97			0.48
Fragilaria ulna	2	2.93	1.95		p	2.88
Gomphoneis eriense	3					0.24
Gomphonema aquaemineralis	3	0.49	p	p	p	0.96
Gomphonema clavatum	2		p			
Gomphonema gracile	2				p	
Gomphonema micropus	2	p	0.24		p	
Gomphonema minutum	3	p	p		p	0.24
Gomphonema olivaceum	3	1.22	2.19	1.88	0.24	1.68

Appendix C (continued)

STREAM:		WSC	CFR	CFR	CFR	LBR
STATION NUMBER:		06	07	09	10	10.2
SPECIES	PT	PRA	PRA	PRA	PRA	PRA
Gomphonema parvulum	1	p	0.97	p	0.24	0.96
Gomphonema pumilum	3	p	0.24			p
Hannaea arcus	3	2.93	0.49			
Melosira varians	2		0.97	p	p	0.96
Meridion circulare	3			p		
Navicula atomus	1	p	0.49	13.88	4.72	0.48
Navicula bacilloides	3	p				
Navicula bremensis	2			p		
Navicula capitatoradiata	2	0.24	p	0.24	p	2.40
Navicula cohnii	2		p			
Navicula cryptocephala	3	p	0.24			
Navicula cryptotenella	2	0.98	7.30	1.88	3.77	0.24
Navicula decussis	3		0.24			
Navicula elginensis	3			p		
Navicula gregaria	2	p	0.49			
Navicula ignota	2	p	p	p	p	
Navicula lanceolata	2		0.49	0.24	p	p
Navicula libonensis	2	p				p
Navicula lundii	2	p				
Navicula menisculus	2	p	p			p
Navicula minima	1		0.49	5.65	5.90	
Navicula minuscula	1	3.18	0.73		p	0.24
Navicula molestiformis	1			0.24		
Navicula pseudoarvensis	3			0.24		
Navicula pupula	2	0.24	p	p	p	
Navicula reichardtiana	2	5.62	5.84	0.47	0.47	12.74
Navicula tenelloides	1	p	p			
Navicula tripunctata	3	0.73	2.68		p	0.24
Navicula trivialis	2		p			
Navicula veneta	1			p		p
Nitzschia acicularis	2	0.73	p	p	0.24	
Nitzschia acidoclinata	3		0.24	0.47	0.24	
Nitzschia amphibia	2		p	p		
Nitzschia archibaldii	2	4.89	0.97	0.94	0.24	16.35
Nitzschia bergii	1			p		
Nitzschia capitellata	2			0.24		
Nitzschia communis	1	p		0.24		
Nitzschia debilis	2			p	p	
Nitzschia denticula	3				p	
Nitzschia dissipata	3	12.47	6.33	14.59	37.50	8.41
Nitzschia draveillensis	1	p				
Nitzschia flexoides	2	p				
Nitzschia fonticola	3	p	5.84			1.20
Nitzschia hantzschiana	3	0.24	0.97	p	0.71	0.72
Nitzschia heufleriana	3	0.24	p		p	
Nitzschia inconspicua	2		2.92	31.53	7.31	1.44
Nitzschia lacuum	3	p				
Nitzschia linearis	2	1.22	3.89	0.94	1.65	
Nitzschia palea	1	1.96	1.70	0.47	3.77	0.72
Nitzschia paleacea	2	3.18	1.95	1.41	14.39	4.57
Nitzschia perminuta	3		p			
Nitzschia pura	2	5.38	0.49		p	
Nitzschia pusilla	1	1.47	p	0.24	0.24	
Nitzschia recta	3	0.49	p			
Nitzschia solita	1					p

Appendix C (continued)

STREAM:		WSC	CFR	CFR	CFR	LBR
STATION NUMBER:		06	07	09	10	10.2
SPECIES	PT	PRA	PRA	PRA	PRA	PRA
Nitzschia supralitorea	2		p			0.24
Nitzschia tubicola	1		p			
Pinnularia appendiculata	3	p				
Rhoicosphenia abbreviata	3	p	7.30		0.47	p
Stauroneis smithii	2	p			p	
Surirella angusta	1	p	p		p	0.24
Surirella brebissonii	2		p		0.24	
Surirella minuta	2	0.49	1.22	0.94	0.94	p
Frustules Counted:		409	411	425	424	416
Total Species:		73	78	49	53	52
Species Counted:		38	48	29	29	37
Shannon Diversity:		4.12	4.85	3.42	3.25	4.25
Pollution Index:		2.56	2.47	2.14	2.35	2.46
Siltation Index:		43.77	45.50	74.82	82.31	50.24
Disturbance Index		26.41	9.25	4.71	0.94	1.92
Total PRA PT Group 1:		6.60	8.27	20.94	15.09	2.64
Total PRA PT Group 2:		30.81	36.50	44.47	34.67	48.32
Total PRA PT Group 3:		62.59	55.23	34.59	50.24	49.04

Appendix C
Diatom proportional count data, Clark Fork Basin biological monitoring, August 17-21, 1997.
PT = Pollution Tolerance group number; PRA = Percent Relative Abundance. A letter "p" denotes species seen during floristic scan, but not during count.

STREAM:		CFR	FTC	CFR	CFR	RKC
STATION NUMBER:		11	11.5	11.7	12	12.5
SAMPLE NUMBER:		0556N	1401E	0652F	0557N	1402E
1997 SAMPLING DATE:		8/20	8/20	8/20	8/19	8/19
SPECIES	PT	PRA	PRA	PRA	PRA	PRA
Achnanthes hungarica	2		p			
Achnanthes lauenbergiana	2		p			
Achnanthes minutissima	3	2.34	1.49	0.49	p	14.81
Achnanthes pusilla	3		p			
Amphipleura pellucida	2			p		
Amphora inariensis	3		p			
Amphora pediculus	3	0.23	0.99	0.25	0.47	
Amphora veneta	1			p		
Aulacoseira crenulata	3		p			
Aulacoseira distans	3		p			p
Caloneis molaris	3	p				
Cocconeis pediculus	3	p	1.24	p		p
Cocconeis placentula	3	0.47	2.73	1.97	1.65	4.13
Cyclotella meneghiniana	2	p	0.74	p	0.71	p
Cymbella affinis	3	2.80	11.17	9.36	4.26	0.24
Cymbella lapponica	3		p			
Cymbella mexicana	3					p
Cymbella minuta	2	p	0.99	p	p	0.73
Cymbella naviculiformis	3					p
Cymbella prostrata	3		p			
Cymbella reichardtii	3	p	0.50	p		
Cymbella silesiaca	3	7.71	1.24	4.43	2.84	0.24
Cymbella sinuata	3	0.93	2.23	2.71	2.60	0.49
Cymbella turgidula	3	p	2.73	10.10	9.46	0.97
Diatoma vulgaris	3	1.40	0.99	9.36	5.91	3.88
Epithemia adnata	2					
Epithemia sorex	3	1.87		5.91	13.95	28.40
Epithemia turgida	3					1.94
Fragilaria brevistriata	3					0.97
Fragilaria capucina	2	2.34	1.49	1.72	2.13	5.10
Fragilaria construens	3	0.70	0.74	p	p	10.92
Fragilaria leptostauron	3		0.25	p		0.97
Fragilaria mazamaensis	3					0.49
Fragilaria pinnata	3		p	0.25		0.73
Fragilaria ulna	2	1.17	0.25	0.99	0.95	1.94
Gomphoneis eriense	3		p			1.94
Gomphoneis minuta	3					0.49
Gomphonema aquaemineralis	3		0.25	0.25	p	p
Gomphonema micropus	2	p	p	p		
Gomphonema minutum	3	p	2.98		p	1.21
Gomphonema olivaceum	3	0.23	p	0.99	1.42	p
Gomphonema parvulum	1	p	0.25	0.25	0.24	p
Gomphonema pumilum	3	p	p	p		0.73
Gomphonema rhombicum	3					0.97
Gomphonema truncatum	3					p
Hannaea arcus	3					p
Melosira varians	2	p				
Meridion circulare	3	p				p
Navicula atomus	1	1.17	2.98		1.42	

Appendix C (continued)

STREAM:		CFR	FTC	CFR	CFR	RKC
STATION NUMBER:		11	11.5	11.7	12	12.5
SPECIES	PT	PRA	PRA	PRA	PRA	PRA
Navicula capitatoradiata	2	p	4.47	0.25	0.24	1.94
Navicula cohnii	2	p	p			
Navicula cryptocephala	3		p			
Navicula cryptotenella	2	6.07	8.19	4.43	3.31	0.24
Navicula difficillima	3					0.24
Navicula elginensis	3		p			
Navicula gregaria	2	p				p
Navicula ignota	2		p			
Navicula lanceolata	2		3.72	0.49	0.47	
Navicula libonensis	2			p		
Navicula minuscula	1	0.23		p	p	p
Navicula molestiformis	1		p	p		
Navicula monoculata	1			p		
Navicula oligotraphenta	3	p	p		p	
Navicula radiosafallax	2		p	p		
Navicula reichardtiana	2	1.87	3.47	0.74	1.42	0.24
Navicula subminuscula	1		p			
Navicula tripunctata	3	p	2.23	p		p
Navicula trivialis	2			p		
Navicula veneta	1				p	
Navicula ventralis	3		p			
Navicula wiesneri	1				p	
Nitzschia acicularis	2	0.23	p	p	p	
Nitzschia amphibia	2				p	
Nitzschia archibaldii	2	1.17	0.25	0.49	0.95	4.37
Nitzschia capitellata	2	p	0.25	p	p	
Nitzschia communis	1	p		p		
Nitzschia dissipata	3	27.80	15.38	20.69	17.26	2.18
Nitzschia draveillensis	1		p			
Nitzschia flexoides	2			0.25		
Nitzschia fonticola	3	p	p	p	0.24	0.24
Nitzschia hantzschiana	3	1.64		0.49	p	0.24
Nitzschia heufleriana	3		p	p	p	
Nitzschia inconspicua	2	27.10	7.20	11.08	6.15	0.49
Nitzschia linearis	2	0.70	2.73	2.22	2.84	p
Nitzschia palea	1	0.70	1.74	0.99	1.42	0.49
Nitzschia paleacea	2	5.84	0.99	4.68	13.48	6.31
Nitzschia perminuta	3				p	
Nitzschia pusilla	1		p			
Nitzschia recta	3		0.25		p	
Nitzschia sociabilis	1	p	1.49	0.25	0.24	
Nitzschia supralitorea	2		0.50			
Pinnularia microstauron	2					p
Rhoicosphenia abbreviata	3	p	5.96	1.23	p	0.24
Rhopalodia gibba	2			p	1.18	p
Simonsenia delognei	2	p				
Surirella angusta	1	0.23	0.25			
Surirella minuta	2	0.70	2.98	0.99	1.42	

Appendix C (continued)

STREAM:	CFR	FTC	CFR	CFR	RKC
STATION NUMBER:	**11**	**11.5**	**11.7**	**12**	**12.5**
Frustules Counted:	428	403	406	423	412
Total Species:	51	68	56	49	53
Species Counted:	28	40	32	30	36
Shannon Diversity:	3.35	4.51	3.93	3.98	3.76
Pollution Index:	2.43	2.46	2.66	2.56	2.77
Siltation Index:	77.34	59.80	49.01	52.01	17.23
Disturbance Index	2.34	1.49	0.49	0.00	14.81
Total PRA PT Group 1:	4.44	7.44	2.46	4.49	0.49
Total PRA PT Group 2:	47.43	39.21	29.06	35.46	21.84
Total PRA PT Group 3:	48.13	53.35	68.47	60.05	77.67

Appendix C
Diatom proportional count data, Clark Fork Basin biological monitoring, August 17-21, 1997.
PT = Pollution Tolerance group number; PRA = Percent Relative Abundance. A letter "p" denotes species seen during floristic scan, but not during count.

STREAM:		**CFR**	**BFR**	**CFR**	**CFR**	**BRR**
STATION NUMBER:		**13**	**14**	**15.5**	**18**	**19**
SAMPLE NUMBER:		0558T	0752R	0897O	0676S	0278V
1997 SAMPLING DATE:		8/19	8/19	8/19	8/18	8/18
SPECIES	PT	PRA	PRA	PRA	PRA	PRA
Achnanthes biasolettiana	3		1.69	0.24	p	1.92
Achnanthes lanceolata	2	0.72	0.48	0.24	0.24	0.72
Achnanthes marginulata	3			p		
Achnanthes minutissima	3	1.44	22.89	11.00	2.88	17.31
Amphipleura pellucida	2		p		p	
Amphora pediculus	3	0.48	0.96	1.22	0.48	0.24
Amphora veneta	1	p			p	
Aulacoseira crenulata	3					p
Aulacoseira distans	3					
Aulacoseira granulata	3					p
Caloneis bacillum	2		p	p		
Cocconeis pediculus	3	p	1.45	0.24	p	p
Cocconeis placentula	3	2.39	7.71	3.18	1.68	5.77
Cyclotella distinguenda	2					p
Cyclotella meneghiniana	2	0.24	0.24	p	0.48	0.24
Cymbella affinis	3	4.31	8.67	9.78	42.79	0.48
Cymbella caespitosa	2		p	p	p	
Cymbella cesatii	3			p		
Cymbella cistula	3					0.48
Cymbella cymbiformis	3					p
Cymbella hebridica	3		p			
Cymbella mesiana	3					0.24
Cymbella mexicana	3					p
Cymbella microcephala	2	p	p			
Cymbella minuta	2		6.51	0.73	0.96	6.01
Cymbella reichardtii	3		p			0.24
Cymbella silesiaca	3	4.07	7.47	3.42	1.92	7.93
Cymbella sinuata	3	1.44	2.41	1.71	1.68	6.01
Cymbella tumida	3					p
Cymbella turgidula	3	15.31	15.42	11.25	17.55	1.44
Diatoma mesodon	3	p	p			
Diatoma vulgaris	3	9.09	0.72	3.91	1.20	0.24
Epithemia adnata	2		p	0.24	p	
Epithemia sorex	3	16.27	0.72	7.58	1.92	
Epithemia turgida	3		0.48	p		p
Fragilaria brevistriata	3			0.49		1.44
Fragilaria capucina	2	1.20	0.96	2.20	0.72	1.44
Fragilaria construens	3	1.20	0.72	0.73	p	0.24
Fragilaria leptostauron	3	p	0.24	p		p
Fragilaria mazamaensis	3	p	p	p		
Fragilaria pinnata	3	p	0.96	0.24		0.96
Fragilaria ulna	2	3.35	0.96	1.47	0.96	1.68
Gomphoneis eriense	3	p	p	0.24		p
Gomphoneis minuta	3					p
Gomphonema acuminatum	3					p
Gomphonema aquaemineralis	3	0.24	p		0.48	
Gomphonema clavatum	2			p		
Gomphonema micropus	2			p	p	
Gomphonema minutum	3	0.24	0.96	0.49	0.24	1.20

Appendix C (continued)

STREAM:		CFR	BFR	CFR	CFR	BRR
STATION NUMBER:		**13**	**14**	**15.5**	**18**	**19**
SPECIES	PT	PRA	PRA	PRA	PRA	PRA
Gomphonema olivaceum	3	0.48	0.48	0.98	0.72	0.24
Gomphonema parvulum	1	p	p		p	0.72
Gomphonema procerum	3		0.24			
Gomphonema pumilum	3	p	0.96	p	0.24	7.45
Gomphonema rhombicum	3		p			0.24
Gomphonema truncatum	3					p
Hannaea arcus	3		p		p	0.24
Melosira varians	2			p	p	1.44
Navicula atomus	1	0.96				0.24
Navicula bryophila	3		p			
Navicula capitata	2					p
Navicula capitatoradiata	2	0.48	1.93	0.73	0.72	15.14
Navicula cohnii	2	p				
Navicula contenta	2				p	
Navicula cryptocephala	3	p	p			p
Navicula cryptotenella	2	0.72	1.20	1.71	0.96	1.68
Navicula decussis	3					p
Navicula gregaria	2					0.24
Navicula halophila	2				p	
Navicula ignota	2				p	0.24
Navicula lanceolata	2			0.24	0.24	p
Navicula menisculus	2		p	p		p
Navicula minima	1	0.24	p			0.24
Navicula minuscula	1				p	p
Navicula oligotraphenta	3		p	p	p	
Navicula perminuta	2				p	1.20
Navicula pupula	2	0.24	p	p	p	p
Navicula radiosa	3		p			
Navicula radiosafallax	2					p
Navicula reichardtiana	2	0.72	2.65	3.18	0.96	2.40
Navicula tripunctata	3		0.24	0.24	p	0.96
Navicula viridula	2					p
Navicula wiesneri	1					p
Nitzschia acicularis	2	0.24		p	0.24	0.48
Nitzschia alpina	3		p	0.24		
Nitzschia amphibia	2	p			p	p
Nitzschia archibaldii	2	0.24	0.96	1.22	0.72	0.48
Nitzschia communis	1	p				
Nitzschia dissipata	3	11.48	5.06	6.85	5.77	3.13
Nitzschia draveillensis	1			p		
Nitzschia flexoides	2			p		p
Nitzschia fonticola	3	p			0.24	0.72
Nitzschia hantzschiana	3	0.48	p	0.49	3.13	1.20
Nitzschia heufleriana	3			0.24		
Nitzschia inconspicua	2	2.63	p	4.16	2.16	0.24
Nitzschia lacuum	3		p	p	p	
Nitzschia linearis	2	1.67		1.22	0.24	p
Nitzschia palea	1	1.67	0.48	2.93	0.24	2.40
Nitzschia paleacea	2	14.83	2.65	14.43	6.97	2.40
Nitzschia perminuta	3			p		
Nitzschia pura	2		0.24			
Nitzschia pusilla	1					p
Nitzschia recta	3		p			p
Nitzschia sociabilis	1				p	
Nitzschia supralitorea	2	p				

Appendix C (continued)

STREAM:		CFR	BFR	CFR	CFR	BRR
STATION NUMBER:		13	14	15.5	18	19
SPECIES	PT	PRA	PRA	PRA	PRA	PRA
Nitzschia vermicularis	2					p
Opephora olsenii	3					p
Pinnularia lundii	2		p			
Rhoicosphenia abbreviata	3	0.24	0.24	p		p
Rhopalodia gibba	2			0.49		
Simonsenia delognei	2			p		
Surirella angusta	1	0.24				
Surirella brebissonii	2					p
Surirella minuta	2	0.48		p	0.24	p
Frustules Counted:		418	415	409	416	416
Total Species:		50	61	60	54	77
Species Counted:		34	34	37	32	44
Shannon Diversity:		3.85	3.91	4.22	3.15	4.30
Pollution Index:		2.66	2.80	2.62	2.83	2.57
Siltation Index:		37.32	15.42	37.90	22.84	33.41
Disturbance Index		1.44	22.89	11.00	2.88	17.31
Total PRA PT Group 1:		3.11	0.48	2.93	0.24	3.61
Total PRA PT Group 2:		27.75	18.80	32.27	16.83	36.06
Total PRA PT Group 3:		69.14	80.72	64.79	82.93	60.34

Appendix C
Diatom proportional count data, Clark Fork Basin biological monitoring, August 17-21, 1997.
PT = Pollution Tolerance group number; PRA = Percent Relative Abundance. A letter "p" denotes species seen during floristic scan, but not during count.

STREAM:		**CFR**	**CFR**	**CFR**	**CFR**	**CFR**
STATION NUMBER:		**20**	**22**	**24**	**25**	**27**
SAMPLE NUMBER:		0272W	273AB	0901N	0903N	0905R
1997 SAMPLING DATE:		8/18	8/18	8/18	8/17	8/17
SPECIES	PT	PRA	PRA	PRA	PRA	PRA
Achnanthes biasolettiana	3	0.48	p	p		1.19
Achnanthes laevis	3					p
Achnanthes lanceolata	2	0.24	0.24	0.24	p	p
Achnanthes minutissima	3	5.26	0.48	2.59	4.31	10.45
Amphora inariensis	3					p
Amphora pediculus	3	1.91	p	0.94	p	p
Amphora thumensis	3					p
Amphora veneta	1		p			
Aulacoseira crenulata	3		p			
Caloneis silicua	2		p			
Cocconeis neodiminuta	3					p
Cocconeis pediculus	3	p	p	p	p	
Cocconeis placentula	3	1.20	1.45	4.48	0.96	p
Cyclostephanos dubius	2					p
Cyclotella comensis	3					0.24
Cyclotella meneghiniana	2	p	p	0.24	p	0.24
Cymbella affinis	3	27.99	39.71	12.03	16.27	30.88
Cymbella cymbiformis	3				0.48	
Cymbella microcephala	2		p			1.66
Cymbella minuta	2	0.48	0.97	1.18	1.20	0.71
Cymbella naviculiformis	3					p
Cymbella reichardtii	3			p		
Cymbella silesiaca	3	1.67	2.91	4.01	1.20	1.19
Cymbella sinuata	3	4.31	4.12	9.67	4.55	0.71
Cymbella tumida	3	p				
Cymbella turgidula	3	34.45	28.33	8.02	26.79	22.33
Diatoma mesodon	3		p		p	
Diatoma tenuis	2				p	1.19
Diatoma vulgaris	3	0.24	0.48	6.84	2.15	0.24
Epithemia adnata	2				p	
Epithemia sorex	3		p		2.39	
Eunotia muscicola	3					p
Fragilaria brevistriata	3			p		p
Fragilaria capucina	2	0.48	1.69	2.83	2.87	12.35
Fragilaria construens	3	0.24	0.24	0.47		0.48
Fragilaria leptostauron	3	p	p	0.24		p
Fragilaria nanana	3					1.43
Fragilaria pinnata	3	p		1.42		p
Fragilaria tenera	2					0.24
Fragilaria ulna	2	1.67	1.45	3.30	5.74	5.70
Gomphonema acuminatum	3			p		
Gomphonema aquaemineralis	3	p	p	0.24	1.91	p
Gomphonema micropus	2			p	0.24	p
Gomphonema minutum	3	p	0.24	1.65		
Gomphonema olivaceum	3	p	0.73	1.89	1.20	0.48
Gomphonema parvulum	1	0.24	0.24	p	0.96	0.24
Gomphonema procerum	3				p	0.24
Gomphonema pumilum	3	0.48	0.48	1.89	0.96	0.48
Gomphonema rhombicum	3					0.24

Appendix C (continued)

STREAM:		CFR	CFR	CFR	CFR	CFR
STATION NUMBER:		20	22	24	25	27
SPECIES	PT	PRA	PRA	PRA	PRA	PRA
Hannaea arcus	3	p		0.24	p	
Melosira varians	2	p	p	p		p
Meridion circulare	3		p			
Navicula aquaedurae	2			p	p	
Navicula atomus	1	p				
Navicula capitata	2			p		
Navicula capitatoradiata	2	0.96	2.42	5.66	3.11	0.95
Navicula cryptocephala	3					p
Navicula cryptotenella	2	4.07	3.39	8.02	3.35	1.43
Navicula decussis	3	p				p
Navicula gregaria	2		p	p	p	p
Navicula ignota	2				p	
Navicula lanceolata	2		p	p	p	
Navicula menisculus	2			p		
Navicula minima	1	p				p
Navicula minuscula	1			p	p	
Navicula oligotraphenta	3			p		p
Navicula perminuta	2	0.24	p			
Navicula pupula	2				p	p
Navicula radiosa	3					p
Navicula radiosafallax	2	p		p		
Navicula reichardtiana	2	1.20	0.24	3.07	2.39	1.19
Navicula tripunctata	3	p	p	1.89	p	0.24
Navicula trivialis	2	p				
Neidium ampliatum	2				p	
Nitzschia acicularis	2		p	p	p	
Nitzschia acidoclinata	3					p
Nitzschia archibaldii	2	0.24		0.47	0.24	
Nitzschia dissipata	3	4.07	5.33	9.91	11.24	3.09
Nitzschia draveillensis	1			p		
Nitzschia fonticola	3	0.24	0.48	0.24	0.72	p
Nitzschia hantzschiana	3	0.72	p	0.24	0.72	
Nitzschia heufleriana	3		p			
Nitzschia inconspicua	2	1.91	p	0.94	p	p
Nitzschia lacuum	3					p
Nitzschia linearis	2	p	0.48	0.47	p	p
Nitzschia palea	1	0.96	0.48	0.47	0.24	p
Nitzschia paleacea	2	3.83	3.39	3.77	3.83	
Nitzschia perminuta	3	p	p		p	
Nitzschia pusilla	1					0.24
Nitzschia recta	3	p				
Nitzschia sociabilis	1			0.24		
Nitzschia vermicularis	2		p			
Opephora olsenii	3			p		
Rhoicosphenia abbreviata	3	p		0.24	p	
Surirella angusta	1	0.24				p
Surirella minuta	2	p		p		p
Tabellaria flocculosa	3					p
Thalassiosira pseudonana	2					p

Appendix C (continued)

STREAM:	CFR	CFR	CFR	CFR	CFR
STATION NUMBER:	20	22	24	25	27
Frustules Counted:	418	413	424	418	421
Total Species:	50	48	55	48	61
Species Counted:	28	24	35	26	28
Shannon Diversity:	3.08	2.79	4.31	3.68	3.15
Pollution Index:	2.82	2.84	2.68	2.75	2.73
Siltation Index:	18.66	16.22	35.38	25.84	7.13
Disturbance Index	5.26	0.48	2.59	4.31	10.45
Total PRA PT Group 1:	1.44	0.73	0.71	1.20	0.48
Total PRA PT Group 2:	15.31	14.29	30.19	22.97	25.65
Total PRA PT Group 3:	83.25	84.99	69.10	75.84	73.87

APPENDIX D

1998 Diatom data

Taxa, proportional count and metrics

Appendix D
Diatom proportional count data, Clark Fork Basin biological monitoring, August 12-16, 1998.
PT = Pollution Tolerance group number; PRA = Percent Relative Abundance. A letter "p" denotes species seen during floristic scan, but not during count.

STREAM:		BTC	SBC	SBC	SBC	SBC
STATION NUMBER:		**SF-1**	**00**	**01**	**2.5**	**4.5**
SAMPLE NUMBER:		1398F	0847M	0102S	0245H	1399F
1998 SAMPLING DATE:		8/16	8/16	8/16	8/15	8/15
SPECIES	PT	PRA	PRA	PRA	PRA	PRA
Achnanthes childanos	3					p
Achnanthes exigua	3	p	p			
Achnanthes hungarica	2		0.24			
Achnanthes lanceolata	2	15.10	11.90	p	p	3.26
Achnanthes minutissima	3	1.60	2.38	3.84	47.02	1.40
Amphora libyca	3	p	p			
Amphora pediculus	3				p	0.23
Amphora veneta	1					1.40
Caloneis bacillum	2				0.48	
Caloneis schumanniana	3		0.24			
Caloneis silicua	2		p			
Cocconeis pediculus	3	p				1.17
Cocconeis placentula	3	0.46	0.24	p	p	7.46
Cyclostephanos invisitatus	2	0.23				
Cyclotella meneghiniana	2	9.84	3.57	p	0.24	7.93
Cymatopleura solea	2		p			p
Cymbella affinis	3					0.23
Cymbella reichardtii	3	p				
Cymbella silesiaca	3	6.41	1.43		p	p
Cymbella sinuata	3	0.23	p		p	1.17
Cymbella turgidula	3					p
Diatoma hyemalis	3				p	
Diatoma mesodon	3			p		
Diatoma vulgaris	3	2.29	1.19			0.93
Diatomella balfouriana	3					p
Epithemia sorex	3					2.10
Epithemia turgida	3					p
Fragilaria capucina	2	3.20	2.14		0.48	8.86
Fragilaria construens	3	19.68	21.67	p		2.33
Fragilaria leptostauron	3			p	p	p
Fragilaria nitzschioides	3		p			
Fragilaria parasitica	2	p	p			
Fragilaria pinnata	3		0.71			0.70
Fragilaria ulna	2	0.23	0.71		p	15.85
Gomphoneis eriense	3					p
Gomphoneis minuta	3	p				
Gomphonema aquaemineralis	3	0.23	0.48			0.23
Gomphonema clavatum	2		p			0.70
Gomphonema micropus	2	p				
Gomphonema minutum	3	3.20	p		p	p
Gomphonema olivaceum	3	p			p	0.47
Gomphonema parvulum	1	1.37	3.57	5.76	0.24	6.76
Gomphonema pumilum	3	0.23				
Gomphonema sarcophagus	2		p			
Gomphonema truncatum	3	p				p
Melosira varians	2	5.49	0.24			p
Meridion circulare	3	p	p		p	p
Navicula agrestis	1	0.69	p			
Navicula aquaedurae	2	0.46	p			

Appendix D (continued)

STREAM:		BTC	SBC	SBC	SBC	SBC
STATION NUMBER:		SF-1	00	01	2.5	4.5
SPECIES	PT	PRA	PRA	PRA	PRA	PRA
Navicula atomus	1	p	1.43	67.87	11.93	p
Navicula capitata	2	0.46	0.24	p		
Navicula capitatoradiata	2	4.58	0.71	p		p
Navicula cohnii	2				p	
Navicula cryptocephala	3	0.23	p			p
Navicula cryptotenella	2	p			p	1.40
Navicula decussis	3	2.29	1.90		p	0.23
Navicula elginensis	3		0.24			
Navicula gregaria	2	0.23	0.48			p
Navicula ignota	2	0.46	p			0.23
Navicula laevissima	3		p			
Navicula lanceolata	2	0.23	0.24		p	0.23
Navicula libonensis	2	p	p			
Navicula lundii	2	0.23				
Navicula menisculus	2	0.23	0.24	p		p
Navicula minima	1	2.29	2.14	20.86	32.22	0.93
Navicula minuscula	1	p	0.71		p	0.23
Navicula mutica	2		p			
Navicula oligotraphenta	3	p	0.24			
Navicula protracta	2	0.23	p			p
Navicula pupula	2	0.69	5.48	p	p	
Navicula reichardtiana	2	1.37	0.24		0.24	1.17
Navicula tripunctata	3	p			p	p
Navicula trivialis	2		p			p
Navicula veneta	1		p	p		
Navicula viridula	2	p				
Navicula wiesneri	1	1.14	0.48			
Neidium dubium	3	0.23				
Nitzschia acicularis	2	0.23	0.24			p
Nitzschia amphibia	2	0.23	0.48			0.23
Nitzschia bacilliformis	3	p				
Nitzschia capitellata	2		0.24			p
Nitzschia communis	1		0.71			
Nitzschia commutata	1		0.24			
Nitzschia denticula	3					p
Nitzschia dissipata	3	3.20	1.43		p	0.47
Nitzschia fonticola	3	0.46				3.50
Nitzschia gracilis	2	p				
Nitzschia hantzschiana	3	0.46	0.24			0.23
Nitzschia heufleriana	3	p	p			
Nitzschia homburgiensis	2	p				
Nitzschia hungarica	2		p			
Nitzschia inconspicua	2	3.20	0.95			3.50
Nitzschia linearis	2	0.92	2.86	p		p
Nitzschia palea	1	1.14	3.57	0.72	0.24	1.63
Nitzschia paleacea	2	0.46	0.71	p		15.85
Nitzschia perminuta	3		0.24			
Nitzschia pura	2	p				
Nitzschia pusilla	1	1.60	3.81		p	0.23
Nitzschia radicula	2	0.23				
Nitzschia recta	3	0.23	p			
Nitzschia supralitorea	2	p	p			0.47
Pinnularia appendiculata	3		p			
Pinnularia microstauron	2		p			
Pinnularia stomatophora	3		p			

Appendix D (continued)

STREAM:		BTC	SBC	SBC	SBC	SBC
STATION NUMBER:		SF-1	00	01	2.5	4.5
SPECIES	PT	PRA	PRA	PRA	PRA	PRA
Pinnularia subcapitata	3	p			p	
Rhoicosphenia abbreviata	3	p	p		p	5.83
Rhopalodia gibba	2					0.23
Simonsenia delognei	2					p
Stephanodiscus hantzschii	2	0.23				
Surirella angusta	1	p	6.43	0.48	1.67	p
Surirella brebissonii	2		7.38	0.24		
Surirella minuta	2	0.23	4.29	0.24	5.25	0.23
Thalassiosira pseudonana	2	1.37	0.71			

Frustules Counted:	437	420	417	419	429
Total Species:	74	75	21	33	64
Species Counted:	48	46	8	11	38
Shannon Diversity:	4.26	4.33	1.40	1.88	4.12
Pollution Index:	2.33	2.10	1.08	2.01	2.17
Siltation Index:	28.38	48.57	90.41	51.55	30.77
Disturbance Index:	1.60	2.38	3.84	47.02	1.40
Total PRA PT Group 1:	8.24	23.10	95.68	46.30	11.19
Total PRA PT Group 2:	50.34	44.29	0.48	6.68	60.14
Total PRA PT Group 3:	41.42	32.62	3.84	47.02	28.67

Appendix D
Diatom proportional count data, Clark Fork Basin biological monitoring, August 12-16, 1998.
PT = Pollution Tolerance group number; PRA = Percent Relative Abundance. A letter "p" denotes species seen during floristic scan, but not during count.

STREAM:		WSC	CFR	CFR	CFR	CFR	CFR
STATION NUMBER:		**06**	**07**	**08**	**8.5**	**09**	**10**
SAMPLE NUMBER:		1020L	0849O	1021H	1049D	0266W	0850O
1998 SAMPLING DATE:		8/15	8/15	8/15	8/15	8/15	8/14
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA
Achnanthes biasolettiana	3	0.48			p		
Achnanthes hungarica	2					p	
Achnanthes laevis	3	p	p				
Achnanthes lanceolata	2	0.24	2.33	p	0.71	0.24	0.24
Achnanthes marginulata	3		p				
Achnanthes minutissima	3	11.46	5.81	4.09	1.89	1.69	4.09
Achnanthes peragalli	3						p
Amphora inariensis	3		p	0.24			
Amphora libyca	3	p		p		p	
Amphora pediculus	3	0.95	1.40	3.37	0.24	0.73	0.72
Amphora veneta	1		1.16	0.48	p		0.24
Anomoeoneis vitrea	2		p				
Aulacoseira alpigena	3	p					
Aulacoseira crenulata	3				p		
Caloneis bacillum	2		0.23	p			
Caloneis molaris	3			p			
Caloneis silicua	2				p	p	
Cocconeis pediculus	3	0.24	3.95	18.99	1.42	0.48	0.72
Cocconeis placentula	3	4.30	9.53	31.97	8.96	4.84	4.81
Cyclotella meneghiniana	2	0.95	6.98	1.92	0.47	0.48	6.25
Cymatopleura solea	2					p	
Cymbella affinis	3	1.43	0.23	p	11.79	2.42	5.53
Cymbella falaisensis	3	p	p				
Cymbella microcephala	2				p		p
Cymbella minuta	2	p	0.70		p	p	p
Cymbella naviculiformis	3		p				
Cymbella prostrata	3		p				
Cymbella reichardtii	3	0.24	0.47	0.24	p		0.24
Cymbella silesiaca	3	19.09	2.09	0.72	2.36	3.15	3.61
Cymbella sinuata	3	4.53	1.16	2.16	0.47	1.21	0.48
Cymbella turgidula	3	5.97	0.23		2.59	1.21	1.44
Denticula elegans	3			p			
Denticula valida	2			p			
Diatoma mesodon	3	0.24	0.23		p		
Diatoma tenuis	2						p
Diatoma vulgaris	3	p	p	0.48	0.24	0.97	1.44
Epithemia sorex	3		0.23	p	0.24	25.67	p
Epithemia turgida	3				p	p	
Eunotia minor	3			p			
Fragilaria brevistriata	3			p	p		0.24
Fragilaria capucina	2	2.63	4.42	1.92	1.65	1.21	0.96
Fragilaria construens	3	1.19	0.93	2.40	0.94	1.69	1.44
Fragilaria leptostauron	3	p	0.47	0.48	p	p	p
Fragilaria mazamaensis	3	p	p				
Fragilaria pinnata	3	1.19	1.86	0.48	p	0.24	p
Fragilaria tenera	2					p	
Fragilaria ulna	2	2.15	0.70	p	p	1.45	0.48
Frustulia vulgaris	2		p				
Gomphoneis eriense	3	p	p				p

Appendix D (continued)

STREAM:		WSC	CFR	CFR	CFR	CFR	CFR
STATION NUMBER:		**06**	**07**	**08**	**8.5**	**09**	**10**
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA
Gomphonema aquaemineralis	3	0.24	p	0.24	0.71		
Gomphonema clavatum	2	0.24	p				
Gomphonema gracile	2						p
Gomphonema micropus	2	p					p
Gomphonema minutum	3	p	p	p			
Gomphonema olivaceum	3	0.95	p	0.48	2.12	3.87	0.72
Gomphonema parvulum	1		2.56	0.96	0.24	0.24	0.48
Gomphonema pumilum	3	p					
Gomphonema truncatum	3	p	0.23		p		p
Hannaea arcus	3	0.48		p	p	p	
Melosira varians	2	0.95	0.23	p	0.71	0.48	1.68
Meridion circulare	3	p	0.23			0.24	p
Navicula agrestis	1				p		
Navicula aquaedurae	2	p					
Navicula atomus	1	p	p		0.71		p
Navicula capitata	2	p	p				
Navicula capitatoradiata	2	0.95	0.47	0.48	1.18	1.94	5.05
Navicula clementis	2	p					
Navicula cryptocephala	3	0.24	0.47				0.24
Navicula cryptotenella	2	2.86	13.26	6.49	13.44	9.44	11.30
Navicula decussis	3	0.24	0.70		0.71	p	
Navicula elginensis	3	p					
Navicula gallica	2						p
Navicula gregaria	2	p	0.70	p	p	p	p
Navicula ignota	2	p	p	0.24	p	p	p
Navicula libonensis	2		p	p			p
Navicula menisculus	2	0.24	0.23	p	0.24	p	p
Navicula minima	1		0.23	1.68		1.69	2.40
Navicula minuscula	1	0.24		p	0.71	p	
Navicula mutica	2		p				
Navicula oligotraphenta	3	p	p	0.24	p	p	
Navicula protracta	2			p			
Navicula pseudoscutiformis	2		p				
Navicula pupula	2	p	p	p	0.24	0.24	0.48
Navicula radiosa	3	p				p	
Navicula radiosafallax	2	p					
Navicula reichardtiana	2	5.97	3.02	0.96	2.59	2.66	3.37
Navicula tripunctata	3	6.44	7.91	1.20	0.24	p	0.24
Navicula trivialis	2			p			
Navicula wiesneri	1	p					
Navicula wildii	2	0.24					
Neidium dubium	3				p		
Nitzschia acicularis	2	2.86	p	0.24	p	0.24	0.24
Nitzschia amphibia	2		p		p		
Nitzschia archibaldii	2	0.72			1.18	0.24	
Nitzschia bergii	1					p	
Nitzschia capitellata	2			0.72		0.73	0.24
Nitzschia communis	1					p	
Nitzschia denticula	3				p		
Nitzschia dissipata	3	13.37	3.02	1.20	9.67	3.87	5.29
Nitzschia draveillensis	1	0.72					
Nitzschia flexoides	2	p			0.24		
Nitzschia fonticola	3	0.24	1.16	0.24	8.73	3.39	5.05
Nitzschia gracilis	2			p	p	0.24	0.48
Nitzschia hantzschiana	3	p	0.93		0.24	0.97	p

Appendix D (continued)

STREAM:		WSC	CFR	CFR	CFR	CFR	CFR
STATION NUMBER:		06	07	08	8.5	09	10
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA
Nitzschia heufleriana	3	0.24	0.23		p	p	0.48
Nitzschia inconspicua	2		5.58	2.16	2.36	8.47	6.73
Nitzschia linearis	2	1.91	p	0.48	0.47	3.15	3.13
Nitzschia microcephala	1		p				
Nitzschia palea	1	1.43	0.47	0.24	1.65	1.69	5.77
Nitzschia paleacea	2	p	1.40	0.24	11.79	1.21	5.29
Nitzschia perminuta	3			p			
Nitzschia pura	2	0.48	0.47	p			
Nitzschia pusilla	1	0.24					
Nitzschia recta	3	p	0.23	p	p	p	p
Nitzschia sigmoidea	3		p				
Nitzschia sociabilis	1		0.23		p	p	p
Nitzschia subtilis	2			p	p	1.21	0.48
Nitzschia supralitorea	2			p			
Nitzschia vermicularis	2			p	p	p	0.24
Pinnularia microstauron	2				p		
Rhoicosphenia abbreviata	3		9.53	9.62	4.25	4.36	5.05
Rhopalodia gibba	2		p		p	0.24	
Rhopalodia gibberula	2	p					p
Simonsenia delognei	2	p					
Stauroneis smithii	2	p	0.23				
Surirella angusta	1	0.24	0.23	p	0.24	p	p
Surirella minuta	2	p	0.23	0.72	0.47	0.24	1.68
Frustules Counted:		419	430	416	424	413	416
Total Species:		76	78	65	71	65	65
Species Counted:		42	49	36	40	41	42
Shannon Diversity:		4.17	4.55	3.56	4.22	4.26	4.65
Pollution Index:		2.71	2.48	2.75	2.54	2.57	2.33
Siltation Index:		39.86	41.86	18.75	58.02	42.86	59.13
Disturbance Index:		11.46	5.81	4.09	1.89	1.69	4.09
Total PRA PT Group 1:		2.86	4.88	3.37	3.54	3.63	8.89
Total PRA PT Group 2:		23.39	41.86	17.79	38.68	35.35	49.28
Total PRA PT Group 3:		73.75	53.26	78.85	57.78	61.02	41.83

Appendix D
Diatom proportional count data, Clark Fork Basin biological monitoring, August 12-16, 1998.
PT = Pollution Tolerance group number; PRA = Percent Relative Abundance. A letter "p" denotes species seen during floristic scan, but not during count.

STREAM:		LBR	CFR	FTC	CFR	CFR	RKC
STATION NUMBER:		**10.2**	**11**	**11.5**	**11.7**	**12**	**12.5**
SAMPLE NUMBER:		1400F	0556O	1401F	0652G	0557O	1402F
1998 SAMPLING DATE:		8/14	8/14	8/14	8/14	8/14	8/14
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA
Achnanthes bioretii	3						p
Achnanthes lanceolata	2	0.25	p	0.49	0.49	0.48	1.18
Achnanthes minutissima	3	5.39	p	1.23	0.49	0.72	23.22
Amphora inariensis	3	p	0.24	p			
Amphora pediculus	3	0.49	p	2.45	0.73	0.48	
Aulacoseira alpigena	3						p
Caloneis bacillum	2			p			
Cocconeis pediculus	3	p	0.97	0.74	0.24	1.20	p
Cocconeis placentula	3	2.21	1.69	2.70	1.47	0.96	4.03
Cyclotella meneghiniana	2	0.25	0.48	0.25	0.73	0.72	p
Cymbella affinis	3	13.97	5.31	11.03	6.36	3.61	0.24
Cymbella caespitosa	2						1.42
Cymbella minuta	2	p		0.25	p	p	1.66
Cymbella muellen	2						6.40
Cymbella prostrata	3	p					
Cymbella silesiaca	3	0.25	0.24	0.49	0.24	p	4.27
Cymbella sinuata	3	0.74	1.45	0.98	1.96	1.20	1.18
Cymbella turgidula	3	2.21	0.48	5.15	2.20	1.45	
Diatoma mesodon	3						0.24
Diatoma vulgaris	3	0.74	0.97	1.47	0.49	0.48	2.37
Epithemia sorex	3	32.60	60.14		54.28	53.25	7.35
Epithemia turgida	3	p	0.24			0.24	0.24
Fragilaria brevistriata	3						0.47
Fragilaria capucina	2	5.88	0.72	3.68	1.22	1.45	1.66
Fragilaria construens	3	0.74	1.93		0.49	1.45	7.11
Fragilaria leptostauron	3	p		p		0.24	1.18
Fragilaria mazamaensis	3	0.74	p				3.08
Fragilaria nitzschioides	3						p
Fragilaria parasitica	2	p		p			
Fragilaria pinnata	3	p					2.61
Fragilaria ulna	2	1.47	0.24	p	0.73	1.45	2.37
Frustulia vulgaris	2						p
Gomphoneis eriense	3	0.49	p				0.24
Gomphoneis minuta	3						0.24
Gomphonema aquaemineralis	3	p		0.25	0.24	p	
Gomphonema micropus	2					p	
Gomphonema minutum	3	p	p	5.64	0.24	p	p
Gomphonema olivaceum	3	3.43	2.17	p	1.96	2.65	
Gomphonema parvulum	1	p	p	0.25	0.24	0.48	0.47
Gomphonema pumilum	3			p			0.71
Gomphonema rhombicum	3						0.47
Gomphonema truncatum	3	p		p		p	
Hannaea arcus	3			p			
Melosira varians	2	0.49		p	1.96	p	p
Meridion circulare	3	p		p			p
Navicula aquaedurae	2			p			
Navicula atomus	1			p			
Navicula capitata	2			p			
Navicula capitatoradiata	2	2.94	0.72	16.91	1.22	0.96	1.90

Appendix D (continued)

STREAM:		LBR	CFR	FTC	CFR	CFR	RKC
STATION NUMBER:		**10.2**	**11**	**11.5**	**11.7**	**12**	**12.5**
SPECIES	PT	PRA	PRA	PRA	PRA	PRA	PRA
Navicula cryptocephala	3					p	
Navicula cryptotenella	2	p	1.93	7.11	2.69	1.20	1.66
Navicula decussis	3	p					
Navicula difficillima	3	p					0.24
Navicula exigua	2	p					
Navicula gregaria	2						p
Navicula ignota	2			p			
Navicula laevissima	3			p			
Navicula lanceolata	2	0.49	0.48	2.45	0.49	0.24	
Navicula libonensis	2	p	p	p			
Navicula menisculus	2			p		p	p
Navicula minima	1		0.97		0.24	p	
Navicula pupula	2		p		p		
Navicula radiosa	3						p
Navicula radiosafallax	2						
Navicula reichardtiana	2	5.39	1.21	5.88	0.98	0.96	1.66
Navicula stroemii	2					p	
Navicula subminuscula	1			p			
Navicula tripunctata	3	p	0.24	0.98		p	0.47
Navicula veneta	1				p		
Navicula viridula	2	p					
Navicula wildii	2						0.47
Neidium binodeformis	2						p
Nitzschia acicularis	2		0.24	p	p		
Nitzschia acidoclinata	3				p	0.24	
Nitzschia amphibia	2			p	p		
Nitzschia archibaldii	2	0.49		0.49	p	0.24	0.47
Nitzschia capitellata	2		p				
Nitzschia communis	1		p				
Nitzschia dissipata	3	12.25	5.80	14.95	7.82	8.67	0.71
Nitzschia fonticola	3	0.98	1.21	1.72	0.49	0.24	p
Nitzschia gracilis	2		0.24		p	p	
Nitzschia hantzschiana	3	0.49					3.79
Nitzschia heufleriana	3	p	p	0.25	p	p	
Nitzschia inconspicua	2	0.25	1.45	1.23	4.16	2.65	0.24
Nitzschia lineans	2		1.69	0.25	p	p	p
Nitzschia palea	1	0.98	0.48	2.21	0.49	2.65	0.24
Nitzschia paleacea	2	3.19	2.42	0.98	1.96	6.51	13.51
Nitzschia perminuta	3						0.24
Nitzschia pura	2		p				
Nitzschia radicula	2	p					
Nitzschia recta	3			0.25			p
Nitzschia sociabilis	1		p	2.94	p	p	
Nitzschia subtilis	2		p			p	
Nitzschia vermicularis	2		0.24		p		p
Opephora olsenii	3						p
Rhoicosphenia abbreviata	3	0.25	1.69	3.68	1.96	1.45	p
Rhopalodia gibba	2	p	1.69		0.49	1.45	
Stauroneis smithii	2			p			
Surirella angusta	1			p		p	
Surirella minuta	2	p	p	0.74	0.24	p	

Appendix D (continued)

STREAM:	LBR	CFR	FTC	CFR	CFR	RKC
STATION NUMBER:	10.2	11	11.5	11.7	12	12.5
Frustules Counted:	408	414	408	409	415	422
Total Species:	53	48	56	45	50	57
Species Counted:	29	32	33	33	31	38
Shannon Diversity:	3.47	2.72	4.09	2.94	2.97	4.11
Pollution Index:	2.77	2.83	2.49	2.81	2.75	2.64
Siltation Index:	27.45	19.32	59.31	20.78	24.58	25.59
Disturbance Index:	5.39	0.00	1.23	0.49	0.72	23.22
Total PRA PT Group 1:	0.98	1.45	5.39	0.98	3.13	0.71
Total PRA PT Group 2:	21.08	13.77	40.69	17.36	18.31	34.60
Total PRA PT Group 3:	77.94	84.78	53.92	81.66	78.55	64.69

Appendix D
Diatom proportional count data, Clark Fork Basin biological monitoring, August 12-16, 1998.
PT = Pollution Tolerance group number; PRA = Percent Relative Abundance. A letter "p" denotes species seen during floristic scan, but not during count.

STREAM:		**CFR**	**BFR**	**CFR**	**CFR**	**BRR**
STATION NUMBER:		**13**	**14**	**15.5**	**18**	**19**
SAMPLE NUMBER:		0558U	0752S	0897P	0676T	0278W
1998 SAMPLING DATE:		8/13	8/13	8/13	8/13	8/13
SPECIES	PT	PRA	PRA	PRA	PRA	PRA
Achnanthes biasolettiana	3			p		1.69
Achnanthes daui	3					p
Achnanthes lanceolata	2	p	0.24	0.24	0.25	0.24
Achnanthes minutissima	3	2.89	4.16	3.36	7.84	19.76
Achnanthes subatomoides	3					p
Amphipleura pellucida	2		2.69	0.24	0.25	
Amphora inariensis	3	p				
Amphora pediculus	3	p	0.98	0.48	p	0.24
Amphora veneta	1		p			
Caloneis bacillum	2				p	p
Cocconeis pediculus	3	p	0.24	0.48	0.98	p
Cocconeis placentula	3	1.93	4.16	2.16	3.19	4.10
Cyclotella meneghiniana	2	0.24	p	0.72	1.23	p
Cymbella affinis	3	2.41	12.22	0.72	8.09	0.24
Cymbella cistula	3		p			
Cymbella cymbiformis	3					0.24
Cymbella gracilis	3			p		
Cymbella mexicana	3					p
Cymbella microcephala	2		0.49	p		
Cymbella minuta	2	p	p	p	0.25	1.45
Cymbella muelleri	2			p	p	0.48
Cymbella reichardtii	3				p	0.24
Cymbella silesiaca	3	0.24	1.47	1.92	0.74	8.19
Cymbella sinuata	3	1.93	0.98	1.20	0.25	0.72
Cymbella turgidula	3	1.45	5.62	0.24	8.82	p
Diatoma mesodon	3		p	p	p	
Diatoma tenuis	2		p	p		p
Diatoma vulgaris	3	1.45	0.49	1.68	2.94	9.64
Diploneis parma	3		p			
Entomoneis ornata	1			p		
Epithemia adnata	2		p			
Epithemia sorex	3	63.86	24.69	52.76	12.01	1.69
Epithemia turgida	3	p	1.47	0.48	p	0.24
Fragilaria brevistriata	3			p	p	
Fragilaria capucina	2	5.06	1.71	2.16	0.74	4.34
Fragilaria construens	3	0.48	0.49	1.92	1.23	1.45
Fragilaria leptostauron	3		p	p	p	1.20
Fragilaria mazamaensis	3	p	0.49			0.48
Fragilaria pinnata	3		0.98	0.72	p	0.48
Fragilaria ulna	2	p	13.45	1.20	0.25	0.96
Frustulia vulgaris	2					p
Gomphoneis eriense	3	0.24	2.44	0.24	p	0.24
Gomphoneis herculeana	3					1.45
Gomphoneis minuta	3		0.73	p	p	0.48
Gomphonema aquaemineralis	3	p		p	0.25	
Gomphonema gracile	2		p			p
Gomphonema insigne	3			p		
Gomphonema micropus	2		p			
Gomphonema minutum	3	0.72	0.98	1.20	2.21	0.96

Appendix D (continued)

STREAM:		CFR	BFR	CFR	CFR	BRR
STATION NUMBER:		13	14	15.5	18	19
SPECIES	PT	PRA	PRA	PRA	PRA	PRA
Gomphonema olivaceum	3	1.20	p	1.20	1.72	
Gomphonema parvulum	1		p	p	0.74	p
Gomphonema pumilum	3		0.73	0.48	p	1.93
Gomphonema rhombicum	3					0.72
Gomphonema truncatum	3		p	p		
Hannaea arcus	3			p		
Melosira varians	2	p	p	0.24	4.17	13.73
Meridion circulare	3				p	0.24
Navicula aquaedurae	2					p
Navicula capitata	2					0.24
Navicula capitatoradiata	2	0.48	1.47	1.44	3.43	6.99
Navicula cryptocephala	3				p	p
Navicula cryptotenella	2	0.48	0.98	3.12	7.60	1.45
Navicula decussis	3				p	p
Navicula gregaria	2		p	p		p
Navicula ignota	2					0.24
Navicula laevissima	3					p
Navicula lanceolata	2			p	0.25	
Navicula libonensis	2			p		
Navicula menisculus	2		p	p		0.24
Navicula minima	1	0.24			p	
Navicula minuscula	1			p		
Navicula notha	2			p		
Navicula perminuta	2					0.24
Navicula pupula	2	p			p	
Navicula radiosa	3			p	p	p
Navicula radiosafallax	2					0.24
Navicula reichardtiana	2	0.24	1.71	0.96	2.45	p
Navicula rhynchocephala	3					p
Navicula tripunctata	3	p	p	0.24	2.45	0.48
Navicula veneta	1				p	
Navicula ventralis	3					p
Navicula wildii	2		p			
Nitzschia acicularis	2					0.24
Nitzschia alpina	3		p			p
Nitzschia amphibia	2				p	0.24
Nitzschia archibaldii	2	p	p			0.72
Nitzschia bacillum	3					p
Nitzschia calida	2			p		
Nitzschia dissipata	3	2.41	3.91	5.04	11.52	3.61
Nitzschia flexoides	2					p
Nitzschia fonticola	3		p		1.96	0.96
Nitzschia gracilis	2	p				
Nitzschia hantzschiana	3	0.72			p	2.41
Nitzschia heufleriana	3			p	p	
Nitzschia inconspicua	2	2.65		1.44	3.43	0.24
Nitzschia lacuum	3		p	p		
Nitzschia linearis	2	p		0.48		p
Nitzschia palea	1	p	1.47	p	0.98	0.48
Nitzschia paleacea	2	7.47	6.60	7.91	4.17	1.45
Nitzschia perminuta	3		0.24	0.24	p	
Nitzschia radicula	2		1.22	p	p	p
Nitzschia recta	3					0.72
Nitzschia sociabilis	1	p	p	0.24	0.25	
Nitzschia solita	1			p		

Appendix D (continued)

STREAM:		CFR	BFR	CFR	CFR	BRR
STATION NUMBER:		13	14	15.5	18	19
SPECIES	PT	PRA	PRA	PRA	PRA	PRA
Nitzschia subtilis	2	p	0.24	0.96	0.49	p
Nitzschia supralitorea	2				p	
Nitzschia vermicularis	2					p
Opephora olsenii	3			p		p
Pinnularia gibba	3					p
Rhoicosphenia abbreviata	3	1.20		1.44	2.94	0.24
Rhopalodia gibba	2	p	0.24	0.24	p	0.72
Surirella angusta	1			0.24		
Surirella minuta	2				p	
Frustules Counted:		415	409	417	408	415
Total Species:		42	57	68	62	79
Species Counted:		23	33	37	34	49
Shannon Diversity:		2.33	3.91	3.12	4.32	4.29
Pollution Index:		2.83	2.66	2.78	2.67	2.65
Siltation Index:		14.70	17.85	22.30	38.97	21.20
Disturbance Index:		2.89	4.16	3.36	7.84	19.76
Total PRA PT Group 1:		0.24	1.47	0.48	1.96	0.48
Total PRA PT Group 2:		16.63	31.05	21.34	28.92	34.46
Total PRA PT Group 3:		83.13	67.48	78.18	69.12	65.06

Appendix D
Diatom proportional count data, Clark Fork Basin biological monitoring, August 12-16, 1998.
PT = Pollution Tolerance group number; PRA = Percent Relative Abundance. A letter "p" denotes species seen during floristic scan, but not during count.

STREAM:		**CFR**	**CFR**	**CFR**	**CFR**	**CFR**
STATION NUMBER:		**20**	**22**	**24**	**25**	**27**
SAMPLE NUMBER:		0272X	273AC	0901O	0903O	0905S
1998 SAMPLING DATE:		8/13	8/12	8/12	8/12	8/12
SPECIES	PT	PRA	PRA	PRA	PRA	PRA
Achnanthes biasolettiana	3	1.22	0.24	p	0.48	1.87
Achnanthes clevei	3		p		p	p
Achnanthes laevis	3					0.23
Achnanthes lanceolata	2		0.73	0.24	p	p
Achnanthes minutissima	3	6.08	4.88	8.89	12.74	19.91
Achnanthes petersenii	3			p		
Achnanthes subatomoides	3				p	
Achnanthes suchlandtii	3		p	p		
Amphipleura pellucida	2				p	
Amphora inariensis	3	0.24		p		p
Amphora libyca	3			p		
Amphora pediculus	3	0.49	0.98	1.92	0.48	2.11
Aulacoseira alpigena	3					p
Aulacoseira crenulata	3					p
Caloneis bacillum	2				0.24	p
Caloneis silicua	2			p		
Cocconeis pediculus	3	p	p	p	p	p
Cocconeis placentula	3	2.92	1.46	3.13	6.01	1.64
Cyclostephanos invisitatus	2				p	
Cyclotella comensis	3					0.23
Cyclotella delicatula	3					1.87
Cyclotella distinguenda	2					0.23
Cyclotella meneghiniana	2	p	0.24	0.96	0.24	p
Cyclotella pseudostelligera	2					0.47
Cymbella affinis	3	36.98	9.76	4.81	2.16	11.94
Cymbella caespitosa	2		p		p	0.47
Cymbella cistula	3		p			
Cymbella cymbiformis	3	p				
Cymbella hebridica	3		p			
Cymbella laevis	3					0.47
Cymbella microcephala	2		p			4.22
Cymbella minuta	2	p	0.24		p	0.47
Cymbella prostrata	3			p		p
Cymbella reichardtii	3	p			p	p
Cymbella silesiaca	3	2.19	1.22	1.68	0.24	1.17
Cymbella sinuata	3	3.16	0.98	3.85	4.09	2.34
Cymbella turgidula	3	7.79	2.68	1.44	0.24	3.98
Diatoma mesodon	3			p		
Diatoma tenuis	2		p	p		p
Diatoma vulgaris	3	2.19	5.37	5.77	3.85	1.41
Epithemia adnata	2				p	
Epithemia sorex	3	4.62	19.02	19.95	34.13	1.41
Epithemia turgida	3				p	
Fragilaria capucina	2	1.46	1.22	1.68	0.72	5.15
Fragilaria construens	3	0.73	1.46	0.72	2.88	1.64
Fragilaria leptostauron	3	p	0.24		0.24	p
Fragilaria mazamaensis	3		p	p		
Fragilaria nanana	3					0.23
Fragilaria parasitica	2			p		

Appendix D (continued)

SPECIES	PT	CFR 20 PRA	CFR 22 PRA	CFR 24 PRA	CFR 25 PRA	CFR 27 PRA
STREAM:		CFR	CFR	CFR	CFR	CFR
STATION NUMBER:		20	22	24	25	27
Fragilaria pinnata	3	0.24	0.49		p	p
Fragilaria robusta	3				p	
Fragilaria ulna	2	0.73	1.46	4.81	3.85	9.84
Gomphoneis eriense	3	0.24	p	p	0.48	p
Gomphoneis herculeana	3	p	0.24			
Gomphoneis minuta	3		p		p	
Gomphonema aquaemineralis	3	p	p			
Gomphonema bavaricum	3	p				
Gomphonema minutum	3	1.46	0.98	0.72	1.20	1.64
Gomphonema olivaceum	3	0.24	0.24	0.72	p	
Gomphonema parvulum	1		p	p	0.24	p
Gomphonema procerum	3		p			
Gomphonema pumilum	3		0.73	0.72	0.24	1.64
Gomphonema rhombicum	3	p		p	0.24	0.94
Gomphonema sarcophagus	2	p			-	
Gomphonema truncatum	3			p		
Gomphonema vibrio	3					p
Melosira varians	2	0.73	5.12	0.72	0.24	p
Navicula agrestis	1				p	
Navicula capitata	2			p		
Navicula capitatoradiata	2	4.62	4.63	5.05	3.13	4.68
Navicula cryptotenella	2	5.11	5.61	3.13	0.96	3.98
Navicula decussis	3	p	p			p
Navicula ignota	2	p				
Navicula laevissima	3					0.23
Navicula lanceolata	2	p	0.24	0.24	p	
Navicula libonensis	2		p			p
Navicula menisculus	2			p		p
Navicula minima	1		0.49	0.24	p	p
Navicula novasiberica	2			p		
Navicula perminuta	2	p	p			
Navicula pseudoventralis	2					p
Navicula pupula	2		0.24	0.24	p	0.23
Navicula reichardtiana	2	2.19	1.22	3.37	0.48	1.64
Navicula tripunctata	3	0.24	0.24	0.24	0.24	0.70
Navicula trivialis	2	p		p		
Navicula viridula	2		p			
Navicula wildii	2					p
Nitzschia acicularis	2	p	0.24	p	0.24	0.23
Nitzschia amphibia	2	p				p
Nitzschia archibaldii	2	0.24	3.66	0.96	0.48	0.23
Nitzschia capitellata	2			p		
Nitzschia denticula	3					p
Nitzschia dissipata	3	7.30	7.32	10.10	6.25	5.39
Nitzschia draveillensis	1	p		0.96	p	0.47
Nitzschia flexoides	2		p			
Nitzschia fonticola	3	p	0.49	0.24	0.24	p
Nitzschia gracilis	2					0.23
Nitzschia hantzschiana	3	0.49	0.73	1.20	1.92	0.23
Nitzschia heufleriana	3	p		p		
Nitzschia inconspicua	2	1.95	2.20	2.64	4.57	0.94
Nitzschia lacuum	3				p	0.70
Nitzschia liebetruthii	3		p			
Nitzschia linearis	2	p	p	p		
Nitzschia palea	1	0.97	2.68	3.37	1.92	1.41

Appendix D (continued)

	STREAM:	**CFR**	**CFR**	**CFR**	**CFR**	**CFR**
	STATION NUMBER:	**20**	**22**	**24**	**25**	**27**
SPECIES	PT	PRA	PRA	PRA	PRA	PRA
Nitzschia paleacea	2	2.68	7.32	4.09	3.13	0.94
Nitzschia perminuta	3			p		
Nitzschia radicula	2		p	p		
Nitzschia recta	3	p				
Nitzschia sociabilis	1	p	p		p	
Nitzschia subtilis	2	p	0.49	0.72	0.24	
Opephora olsenii	3					p
Rhoicosphenia abbreviata	3	0.49	1.22	0.48	0.96	
Rhopalodia gibba	2	p	0.49	p	p	
Surirella angusta	1	p		p		
Surirella minuta	2	p	0.49	p		
Thalassiosira pseudonana	2			p		0.23
Frustules Counted:		411	410	416	416	427
Total Species:		58	65	65	59	70
Species Counted:		30	42	35	36	43
Shannon Diversity:		3.60	4.37	4.27	3.67	4.35
Pollution Index:		2.78	2.58	2.62	2.77	2.62
Siltation Index:		25.79	38.29	36.78	23.80	22.25
Disturbance Index:		6.08	4.88	8.89	12.74	19.91
Total PRA PT Group 1:		0.97	3.17	4.57	2.16	1.87
Total PRA PT Group 2:		19.71	35.85	28.85	18.51	34.19
Total PRA PT Group 3:		79.32	60.98	66.59	79.33	63.93